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DEPARTMENT OF AGRICULTURE.

BOTANICAL DIVISION.

BULLETIN NO. 10.

SECTION OF VEGETABLE PATHOLOGY.

REPORT

ON THE

EXPERIMENTS MADE IN 1888 IN THE TREATMENT OF THE DOWNY MILDEW AND BLACK ROT

OF THE

GRAPE VINE.

PREPARED UNDER THE DIRECTION OF THE SECRETARY OF AGRICULTURE.

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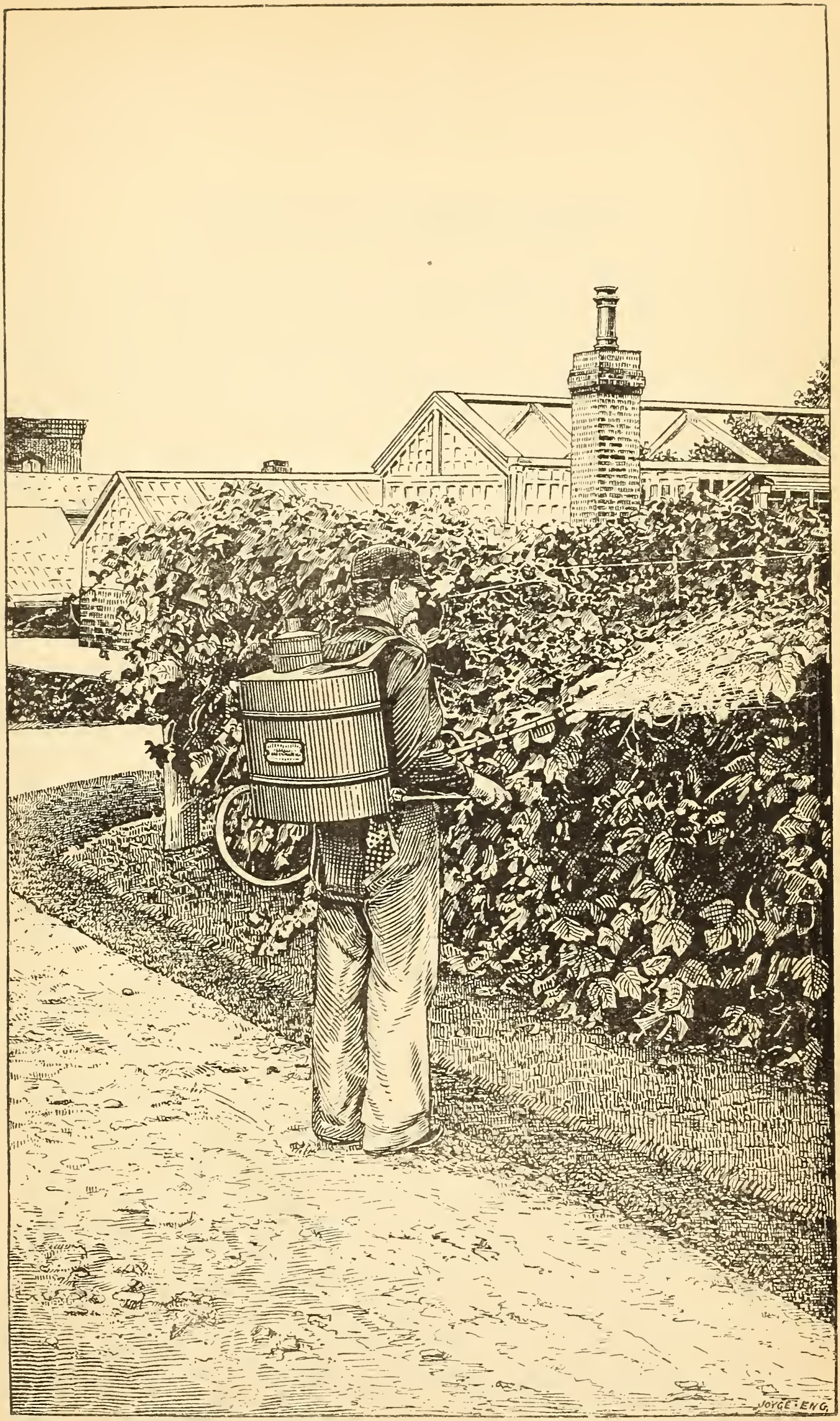
LETTER OF SUBMITTAL.

SIR: I have the honor to submit herewith a report on the experiments made in 1888 in the treatment of the downy mildew and black-rot of the grape vine. These diseases have ravaged our vineyards for more than half a century, and it is therefore gratifying to announce that through the efforts of this Department they are at last practically under control.

Much yet remains to be accomplished in the way of determining the cheapest and most effectual method of treating these maladies. It is believed, however, that the experiments planned for the coming season will throw considerable light on this subject.

B. T. GALLOWAY,
Chief of the Section of Vegetable Pathology.

HON. J. M. RUSK,
Secretary of Agriculture.



EUREKA SPRAYER IN USE.

REPORT OF F. LAMSON SCRIBNER.

The results of the experiments made in 1887 were not conclusive, yet they were sufficiently encouraging to render apparent the importance of continuing them. Therefore, early in the spring of the present year (1888), the Commissioner of Agriculture directed me to make arrangements for repeating the same line of experiments in treating the downy mildew and black-rot of the vine. With one exception, that of Mr. Munson, of Denison, Texas, the services of the special agents employed last season were secured to carry on the work in their respective vineyards. In addition to this, a circular letter of instruction was directed to those who last year made volunteer reports, with the request that should they engage in the experiments they would report the results to the Department. Although many signified their intention of trying one or more of the remedies recommended, very few reports were received at the close of the season.

The work of the special agents was very carefully performed, and has been crowned with success; their reports are here presented in full.

The experiments last year completely demonstrated the efficacy of the salts of copper in treating the downy mildew, but their value in the case of black-rot was left in doubt. As stated in a former report (bulletin 5, page 42), the failures in 1887 in treating this disease were probably due to the tardiness of the applications, and treatments begun earlier might meet with better results. The experience of the past season shows this supposition to have been correct. Where the applications have been made early, before the fungus of black-rot had become established on the foliage, before the period of bloom even, and repeated at intervals of ten to fifteen days, the results have been such as to justify the conclusion that we now have both downy mildew and black-rot, the two worst enemies to American viticulture, entirely under our control.

Directions were given to our agents to begin the applications at an earlier date than last year (1887) and to omit further trials with the simple solution of sulphate of copper, it having injured the foliage in so many cases, that its further use was not deemed advisable. Instructions were given to use the Bordeaux mixture with the proportions of lime and sulphate of copper reduced to six pounds, eau celeste prepared according to the original formula with the addition of carbonate of soda, the ammoniacal carbonate of copper solution, and sulphatine.

Of these last-named remedies sulphatine, a powder composed of lime, sulphate of copper, and sulphur, gave the least satisfaction, and its further use, excepting in special cases or in an experimental way, can not be recommended. The experiments with the ammoniacal solution of carbonate of copper did not begin early enough to afford a test of its value as a remedy for black-rot, but its effectiveness in controlling the mildew was fairly determined, and should it prove, after further experiments begun earlier in the season, to be equally valuable as a remedy for the rot, it doubtless will supplant the other preparations named, as it is more easily prepared and applied and is less expensive. The cost of the materials used and the labor of making the applications, however, is very small in any case when compared with the value of the increased production shown by the reports of special agents.

Eau celeste completely protected the vines from mildew, but for black-rot it was much inferior to the Bordeaux mixture, especially at Vineland, N. J. At all of the stations it was this latter preparation which gave the best results. This was the case especially at Vineland, where the amount of sulphate of copper was only 6 pounds to 22 gallons of water. The Bordeaux mixture is the most expensive of the remedies used, but if applied with the improved Vermorel or other spraying nozzle adapted to this compound it is as easily applied as any. Assuming that we would use 44 gallons to the acre at each application, we estimate the cost of materials for five applications to be $5.20; sulphate of copper reckoned at 7 cents per pound and lime at $1.10 per barrel. With the Eureka sprayer a good man can spray 5 acres in a day which, estimating his labor at $1.50, makes a total cost of $6.70. To this should be added the cost of the spraying pumps, but the pump is good for any number of acres, and with proper care will last for several seasons.

We deem that the tests made with the Bordeaux mixture have fully demonstrated its efficacy in combating both mildew and black-rot, and in the present stage of our experiments it is the only compound which we can recommend without reservation.

Learning through the special agent at the station in New Jersey of the manifest beneficial effects being obtained there, the Commissioner directed me to visit Vineland July 29, to inspect the field of experiment. In reporting to the Commissioner the observations made during this visit I said:

> The results already obtained at Vineland, N. J., demonstrate beyond a doubt the possibility of preventing black-rot by application to the vines of solutions having sulphate of copper for a base.
>
> The season at Vineland has been particularly favorable to the development of the fungus of the rot, and in Colonel Pearson's vineyard all untreated Concords have been destroyed; even Norton's Virginia has lost a good share of its berries by the disease. The Ives has been slightly attacked, while the Iron-clad shows as yet no sign whatever of rot either upon its foliage or berries. In cases where Concords and Iron-clads were growing alternately in the same row, the fruit of the former was destroyed while not a leaf or a berry of the latter was affected.

It is the Bordeaux mixture which has given the best results; the contrast in respect to rot between the places where this preparation was applied and those where eau celeste and other compounds were used being very marked.

Five applications have been made, the liquids being applied with the Eureka sprayer May 29, June 4 and 21, July 2 and 11. Black-rot appeared on the untreated Concords June 27. This resulted from a period of infection that occurred about June 21, as was shown by experiments made in bagging grapes—those bagged prior to this date being entirely free from disease, while those subsequently covered were all more or less affected. The unprotected berries attacked at this period are now dry and shriveled. No such diseased berries can be found on the vines treated with Bordeaux mixture, showing that they entirely escaped this first attack. We can only account for this immunity on the ground that infection was prevented by the remedy.

June 15. The disease was progressing very rapidly on the untreated Concords. On July 20 there was no sign of rot on the treated vines, while on the untreated of the same variety two-thirds of the crop had been destroyed. About July 26 rot appeared on the treated vines, but was chiefly confined to bunches hidden under masses of foliage where the spray was least likely to reach them. Clusters fully exposed to the spray were freest from rot; on the untreated vines all bunches were alike diseased. At the date of my visit very few clusters on the untreated vines had more than two or three sound berries; at least 95 per cent. were destroyed; on the treated vines there was, as stated, some rot, particularly on the most sheltered bunches, but the attack was evidently a recent one as none of the diseased berries had reached the blackened and shriveled state of those attacked early in the season. The loss might amount to 10 or 15 per cent.

The favorable effects of the treatment with the Bordeaux mixture were most convincing as to its value. Had the vines been sprayed again about July 17, and particular attention given to reaching all the clusters, I am confident that the loss from black-rot on the vines treated with the Bordeaux mixture would not have exceeded 2 per cent.

The results from the use of sulphatine are inferior, yet better than those obtained with eau celeste.

I do not consider that the treatment made by Colonel Pearson on August 8 had any effect on the rot one way or the other; it was doubtless useful, however, in warding off late attacks of mildew, which often occasion serious injury. The activity of the black-rot fungus about July 17, the period of the second attack, was the last dangerous period of the season. Before a third attack could be made the berries were too mature to be affected by the parasite.

The number and date of the applications made at the Vineland Station have been stated above. The results obtained were as follows:

With the Bordeaux mixture, the yield from thirteen treated vines was 80 pounds; yield from thirteen untreated vines (same variety, parallel and adjacent row to that treated) $2\frac{1}{4}$ pounds.

With eau celeste, the yield of fourteen treated vines was 14 pounds; yield of fourteen untreated vines, 4 pounds.

With sulphatine, the yield of twenty-five treated vines was 20 pounds; yield of twenty-five untreated vines, 4 pounds.

The severity of the disease is indicated by the almost total destruction of the crop on the untreated vines.

Table showing result of experiments made at Charlottesville, Va.

Preparation used.	Date of application.	Loss from rot.	
		Treated.*	Untreated.†
		Per cent.	*Per cent.*
Sulphatine	May 11, 31, June 22, July 20 ‡	15	25-30
Bordeaux mixture (first formula)	May 11, June 2, July 5	5-10	60-65
Bordeaux mixture (second formula)	May 12, June 2, July 5	10-12	33
Eau celeste (first formula)	May 18, June 5, 22, July 13	5	33
Eau celeste (second formula)	May 18, June 5, 22, July 13	10-15	40-45
Ammoniacal carbonate of copper solution.	May 30, June 18, July 10	20-25	50-60

* No mildew in any case.
† Considerable mildew in all cases.
‡ Number vines treated, 142; total amount powder used, 40 pounds.

At the station in Missouri, conducted by Mr. Herman Jaeger, the condition of the crop during the first week in August, just prior to the harvesting of the earliest varieties, was noted, and it was estimated that the average loss per cent. from rot on the twenty-one varieties treated with the Bordeaux mixture was 16.8; treated with eau celeste, 18.7; untreated, 31.7.

The difference in the severity of the rot on different varieties, as stated by Mr. Jaeger, is very striking and instructive. It varies from practically nothing in Elvira, Mo. Reisling, Lincecumii Nos. 13 to 43, and Rupestris type, to 75 per c ent. in North Carolina, Herbermont, and Lincecumii No. 9.

CONDENSED REPORTS FROM CORRESPONDENTS.

Mr. G. W. Fisher, of Montclair, N. J., reported experiments made in treating downy mildew with eau celeste, prepared according to the original formulas, and also with the addition of carbonate of soda. The latter compound he prefers, and proposes to use it only in the future. The eau celeste did not burn the foliage as it did last year (1887), but the applications of the present season were all made after sundown. The treatment afforded complete protection against mildew. There was no black-rot on any of the fruit.

Mr. Joseph Nehr, of Egg Harbor, N. J., treated his grapes for black-rot, using preparation No. 19, of Circular No. 5. Applications were made to the bunches June 16, July 7, and July 16, the variety treated being Concord.

The amount of material used was 6 pounds anhydrous sulphate of copper, 60 pounds sulphur, and 6 pounds air-slaked lime.

Cost of material, about $2 per acre for each application; cost of labor, $3 per acre for each treatment.

Black-rot appeared June 28, destroying about 10 per cent. of the fruit on the untreated vines, those treated remaining healthy. By July 11 the untreated grapes were nearly all destroyed, while those treated showed only a few infected berries. Mr. Nehr deems the remedy he used "a good preventive of black-rot," but thinks bagging the bunches "cheaper and just as good."

Mr. D. A. Vandeweer, of Manalapan, N. J., experimented with eau celeste (modified formula) for black-rot, spraying the vines four times, viz: June 1 and 9 and July 4 and 25. The treatment afforded no marked success, the vines mildewed badly, and the fruit was nearly all destroyed by the rot.

Mr. R. H. Stratton, president of the Piedmont Fruit Growers' Association, states that he used the Bordeaux mixture "with signal success," not only stopping the mildew after it had appeared, "but preventing the rot." His treated Nortons gave perfect clusters, without any rot, while in neighboring untreated vineyards of that variety the rot was severe.

Mr. Henry L. Jeffry, of Woodbury, Conn., reports that heavy applications of Bordeaux mixture, after black-rot had appeared, served to check all further progress of the disease.

Mr. Thomas Brigden, of South Lowell, Ala., has been led to think, from experiments made by him, that the solution of sulphate of copper is a specific for mildew and a great preventive of black-rot.

Mr. Edward Roessler, of Shelbyville, Ill., treated his vines with eau celeste modified by the addition of carbonate of soda (formula 5 of circular 5). Number of vines treated, twenty-nine—twenty-five Concord and four Clinton. Amount of material used, 22 gallons; cost, 70 cents. Cost of labor in preparing and applying the solution, $1. First application, June 12; second, June 18; third, June 26; fourth, July 4. After this, applications were made once a week for six weeks. Result satisfactory. Rot appeared June 16 on all the vines (seventy-five) in the vineyard, but after the second application did not develop any further on the treated vines. The disease continued on the vines not treated until there were only here and there a few grapes left. Those treated gave a yield of from 15 to 20 pounds per vine. There was a great difference in the foliage on the treated and untreated vines. By September 17 the foliage on the former was still adherent and in a healthy condition; on the latter the leaves had all fallen. Mr. Roessler concludes by saying: "I think this remedy possesses great merit, and will test it again next year to entirely satisfy myself."

Mr. John Hertlein, of Spilerville, Logan County, Ark., reports successful treatment of black-rot with the simple solution of sulphate of copper. He made three applications; April 18, May 2, and May 20. Four hundred vines, embracing several varieties, were treated. A row through the middle of the vineyard was left untreated, to serve as a check on the experiment. Strength of solution used at first application was 1 pound to 20 gallons. This burnt the foliage of Ives, Norton's Virginia, Mo. Riesling, and Berckmans, but not that of Delaware. Strength of solution of second and third application was 1 pound to 30 gallons. Even at this strength the foliage on some varieties was injured where the applications were made in the morning. No injury resulted to the foliage when applications were made in the evening.

Black-rot was first seen May 26. By the 1st of July the difference between the treated and untreated vines was very marked; very little rot on the former, while the latter were badly rotten. The varieties were not all alike protected by the applications. There was no visible difference between treated and untreated Berckmans and Vergennes; both rotted equally, while the difference between the treated and untreated Concords was very striking. The former yielded at harvest (August 6) 10 pounds on an average per vine, the latter only 3½ pounds. Mr. Hertlein says that he has entire confidence in the remedy (simple solution of sulphate of copper).

TREATMENT OF BROWN-ROT.

The experiments made by Mr. George M. High, of Middle Bass, Ohio, in treating brown-rot with eau celeste will be particularly interesting to vineyardists of the islands and adjacents parts of Ohio, also those of western New York; regions where brown-rot is more prevalent and destructive than black-rot.

Mr. High used eau celeste in his experiments, treating a number of varieties, chiefly Catawbas. The solution was prepared as follows: One pound of copper sulphate was dissolved in from 2 to 3 gallons of hot water; and when cold, 1 pint of spirits of ammonia was added. The solution was then allowed to stand for twenty-four hours, the clear liquid (to the amount of 2 gallons if 3 gallons were used) was then poured off, and what remained was diluted to 22 or 25 gallons. There was no injury done to the foliage excepting occasionally where a vine got a thorough drenching owing to the stoppage of the horse.

The apparatus used in applying the spray was a Nixon barrel force-pump and sprayer carrying a No. 4 climax nozzle.

The first application was made June 7, about ten days before bloom. One-half of the vineyard—the east side, embracing about two thousand vines—was again sprayed June 18, when the blossoms were just beginning to fall. To the same vines the applications were repeated July 6 and 18 and August 7. There were hardly any signs of mildew or rot in this lot of vines August 16, while at the same date some two thousand untreated vines adjoining had lost from one-fourth to one-third of their berries from rot and their foliage was much injured by mildew.

Two thousand vines on the west side treated with the eastern lot June 7 were again treated June 25, July 7 and 14, and August 7. This lot rotted slightly, but not to an extent exceeding 2 per cent. of the crop.

The season throughout was warm and moist, the soil being continually damp. All the conditions were particularly favorable to the development of both mildew and rot. Mr. High says that he does not think that there is a vineyard of Catawbas on North Bass or Put-in-Bay Islands which has not suffered a loss from these diseases of from 25 to 33 per cent. or more of the crop, while on his vines treated with eau celeste the loss will not amount to 1 per cent.

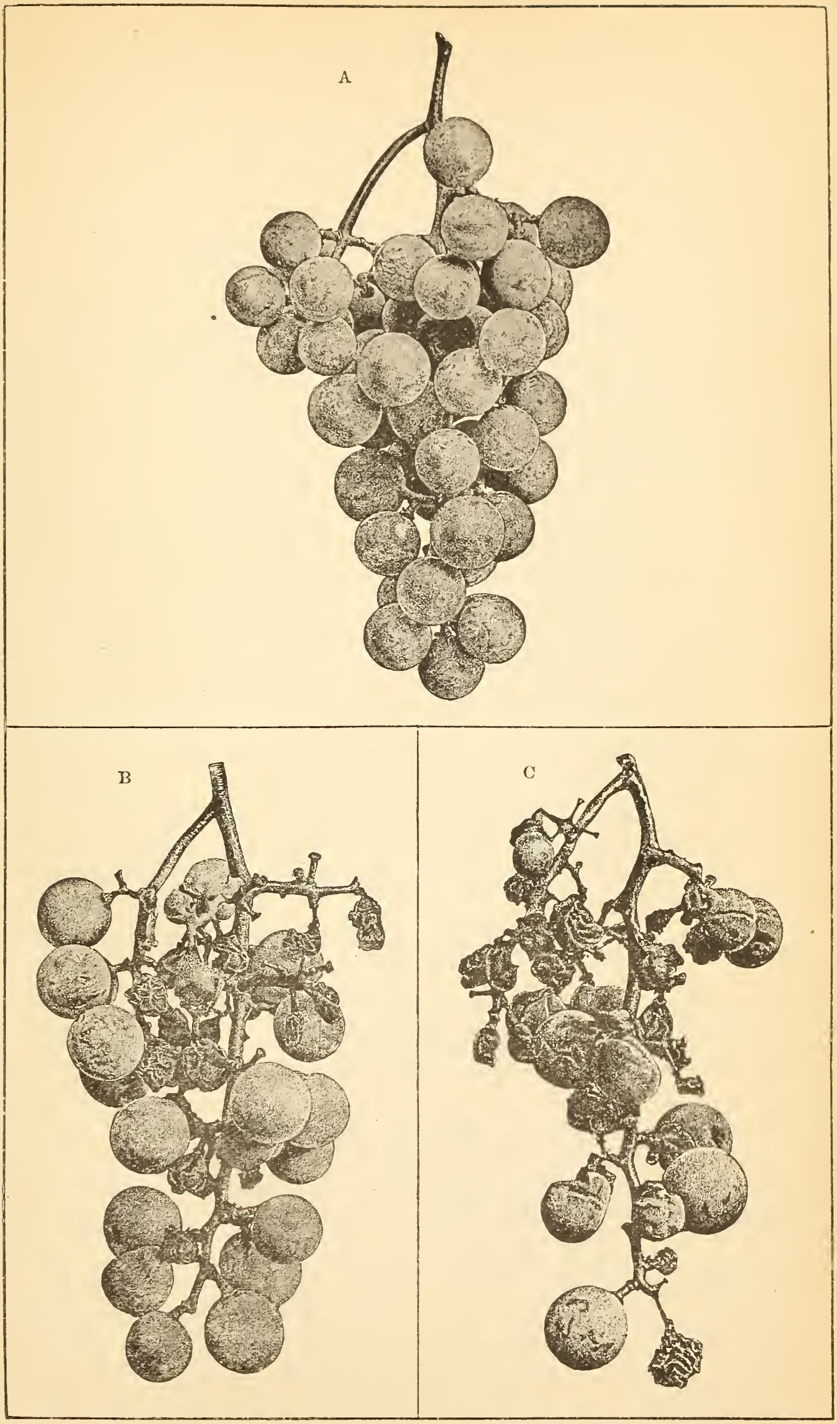
The amount of material used per acre—vines planted 6 by 7 feet—was 56 gallons for each application, the material used costing 33 cents. The barrel-pump and sprayer cost $35 exclusive of freight. No price is quoted for the labor, but, with the apparatus used, two men and a horse were required, the spray being applied as fast as the horse could walk between the rows.

In a communication dated September 28, Mr. High reports that the vines treated continue to hold both foliage and fruit in an almost perfect condition. The untreated vines (Catawbas) have lost more than half their foliage, while the greater part of the fruit yet unaffected by the rot will not ripen.

Respectfully,

F. LAMSON SCRIBNER.

HON. J. M. RUSK,
Secretary of Agriculture.



COMPARISON OF TREATED AND UNTREATED GRAPES FROM COLONEL PEARSON'S VINEYARD.

A, cluster from treated vines; B, the best to be found on untreated vines; C, general appearance of clusters on untreated vines.

EXPERIMENTS AT VINELAND, N. J. (Season 1888.)

SIR: I have the honor to submit this report of experiments made by me during the summer of 1888 to test the efficacy of the preparations of copper sulphate as preventives of fungous diseases of plants.

Early in May I received a letter from the Chief of the Section of Vegetable Pathology prescribing formulæ to be used in the treatment of vine diseases, and suggesting the expediency of commencing such treatment earlier than in 1887, when the vines were not sprayed until June 13, too late to prevent infection of black-rot.

The chemicals requisite were at once ordered from Philadelphia, but received only after some delay, and there was some further delay in obtaining a spraying machine. Hence the first treatment of the vines was not made until May 29. The various solutions were then applied with a machine employed as a make-shift, requiring nearly two days to do what may in three hours be done with the Eureka sprayer.

The solutions of copper sulphate were:

Eau celeste.—One pound copper sulphate; 1½ pints liquid ammonia; 22 gallons water.

Eau celeste (second formula).—One pound copper sulphate; 1 pound carbonate of soda; 1½ pints ammonia; 22 gallons water.

Bordeaux mixture.—Six pounds copper sulphate; 4 pounds fresh lime; 22 gallons water.

Sulphatine (powder).—The method of combining these ingredients has been already published.

The vineyard subjected to these experiments is that which was treated in 1887, and which I then described. There are in it eleven rows of Concord grapes, running north and south, one hundred and ten vines in each row.

Six nearly equal sections of this vineyard, crosswise of its rows, were assigned to the six preventives of grape fungi to be tested:

To the south section (No. 1), *solution of ammoniacal sulphate of copper*, prepared as directed in circular No. 5, Section of Vegetable Pathology, page 7.

To section No. 2 I applied a powder containing one part flowers of sulphur, two parts air-slacked lime.

Section No. 3 I sprayed with *Bordeaux mixture.*

Section No. 4, with *eau celeste*, first formula.

Section No. 5, with *eau celeste*, second formula.

Section No. 6 was dusted with *sulphatine.*

The sixth, or middle, one of the eleven rows of this vineyard, traversing all the sections, was left untreated for comparison.

May 29—vines not yet in blossom—I sprayed section 3 with the *Bordeaux mixture;* sections 4 and 5 with the formulas of *eau celeste*; dusted section 6 with *sulphatine,* and section No. 2 with the powder of sulphur and lime. There were then no symptoms of any fungous disease on the vines.

In another vineyard I found at this date anthracnose on vines which were attacked by this disease in 1887. Concerning these I will state that I sprayed them June 1 with the *Bordeaux mixture*, repeating the treatment June 5. I saw no benefit from these applications and infer that the copper sulphate solutions will avail against anthracnose only when used preventively, before infection.

During April and May the weather was wetter than usual. In May there were occasional foggy mornings, rare here at that season. These atmospheric conditions justified the apprehension of an early invasion of the black-rot, and hence, to be on the safe side, I sprayed and dusted the vines again on June 4.

The first leaf spots, *Phyllosticta labruscæ*, indicative of activity of the black-rot germs, appeared June 2.

On June 5 the Ironclad was in full bloom, Ives blossoms nearly opened, Concord clusters just visible in bud. On June 14 the Concords were in full bloom.

Having obtained some carbonate of copper I made a solution of it according to the formula, and on June 18 used it in spraying section 1 of the experiment vineyard for the first time.

On June 21 I again sprayed and dusted all the sections from 1 to 6.

Weather through June continuously clear and hot, with now and then a foggy morning.

On June 23, p. m., heavy thunder and lightning, but only a spatter of rain, scarcely enough to lay the dust. The mercury ranged that day up to 98°. On June 27 I found the first specks of black-rot, which probably had been visible about two days, on berries of untreated Concords.

One inch of rain fell on the night of June 27, ending a drought of twenty-eight days. Rain all the next day saturated the soil.

On July 2, beginning at 4 a. m., I for the fourth time treated all the sections of the experiment vineyard. The first attack of grape rot appeared to have ceased.

On July 7 there was a heavy shower at 4 p. m.

Foggy morning on July 11, when I made the fifth application of the copper solutions.

On July 12 fresh rot specks appeared in great numbers, but much less numerously on sprayed than on unsprayed vines.

On July 15 a few friends came to inspect the experiment vineyard. They concurred with me in the conclusion that the results of the experiments had demonstrated that the preparations of copper sulphate, the Bordeaux mixture especially, are preventive of black-rot.

Verifying this, I quote from a letter of Dr. E. C. Bidwell, of Vineland, to Professor Viala, dated at Vineland, N. J., July 25, and published in *Le Progrès Agricole et Viticole*, printed at Montpellier, France, August 12, 1888:

> You will be interested to learn the results obtained by employment of the copper solutions for black-rot at the experimental station of Colonel Pearson.
>
> Last year success was doubtful.
>
> July 15, 1888, I inspected the vines treated this year, and am happy to state that the rows treated when in bloom, and with care that the clusters might be sprayed, are almost entirely exempt from black-rot.
>
> The result is not perfect, but there is a considerable difference between the rows treated and those not treated.
>
> July 25, I learn that these effects continue manifest.

Rain and fog were frequent during July, and by the last of the month all untreated Concord grapes were totally destroyed by black-rot.

July 30, Professor Scribner inspected the experiment vineyard, and found satisfactory evidence of the efficacy of the copper solutions and caused photographs to be made of grape clusters untreated and those treated by Bordeaux mixture. (See Plate II.)

During the rest of the summer the rot continued (on vines not protected) so long as there were grapes left to rot. On one patch of five hundred Concords, which I neglected, and where the decidua of the previous crop was permitted to remain on the ground beneath the vines, there is not remaining at this date (September 15) an average of one berry per vine, yet in June these vines hung full of fruit.

August 8, I treated the experiment vineyard for the sixth and last time.

Downy mildew did not appear epidemically until about August 10, and has not prevailed severely, confirming what I have already remarked, that mildew is worst in hot and dry summers. This summer has been in this region generally cool and moist—a "good year for grass."

RESULTS OF EXPERIMENTS.

September 17, the Concord grape is about ripe, and my vintage begins to-day.

In the experiment vineyard, the untreated row traversing all the sections is easily distinguished by its foliage being burnt and withered by *Peronospora.* This row looks brownish, while the other ten rows are green. There are mildewed leaves on all the rows and through all the sections, but the sick leaves on the treated rows are those which accidentally escaped being wet with the copper sulphate. Those leaves which were formed in May, and sprayed with the solutions, are green and healthy.

Section 2, treated with lime and sulphur powder, and section 6, treated with sulphatine, show decidedly the efficacy of these in preventing mildew.

I have omitted to state that—being somewhat partial to the powders and desirous to give them a fair chance—I dusted sections 2 and 6 more frequently than I treated the other sections—nearly twice as often. I notice that a fine powder, distributed with a bellows, is blown more thoroughly into the vine where the foliage is dense and the outer leaves obstruct a liquid spray.

In ordinary seasons, and applied, say, once in two weeks, either of the copper sulphate preparations above described—liquid or powders—will be adequately protective against mildew.

PROTECTION FROM BLACK-ROT.

As regards the protection afforded by the various preparations of copper sulphate against black-rot (*Læstadia Bidwellii*) results vary remarkably.

On the untreated row, which traverses all the sections, the grapes are almost totally rotted. One or two sound grapes may be found remaining on a few clusters, but at least nine-tenths of the bunches show only a mass of dried and shriveled victims of the fungus.

On all the sections prevention of rot by copper sulphate is perceptible, but on none is it strikingly so, excepting on section 3, sprayed with the Bordeaux mixture. Here the treated rows have many clusters, showing but one or two rotted berries in each. There is a good deal of grape rot on these rows—but it is seen only on the clusters which did not receive any spray of the Bordeaux mixture.

In the spraying of this vineyard, which was with a good portable pump, fitted with the cyclone nozzle, no especial care was taken to spray the clusters. Where these hung exposed beneath the trellis they were wet with the liquids, but where shielded by the foliage they received little or none.

Where the grape clusters were wet with the Bordeaux mixture early and often, they are saved from rot. Where not thus sprayed they are rotted.

However, comparison of the treated and untreated rows shows the contrast between a moderately fair crop and nothing.

To more exactly determine the effect of the treatments I gathered the fruit on the untreated row and weighed it; likewise that on an adjacent row, treated with the Bordeaux mixture.

Yield of untreated and treated rows for the several sections.

Sec.	Treatment.	Untreated row.		Treated row.	
		Vines.	Yield of grapes.	Vines.	Yield of grapes.
			Pounds.		*Pounds.*
3	Bordeaux mixture	13	2¼	13	80
4	Eau celeste (formula 1)	13	2	13	6½
5	Eau celeste (formula 2)	14	4	14	14
6	Sulphatine	25	4	25	20

These contrasts are instructive. From inspection of them viticulturists can choose the formula they want. The superiority of Bordeaux mixture is so manifest that hereafter I shall use it only, with confidence that by early, thorough, and frequent applications I may save my entire grape crop.

TREATMENT OF THE VINES.

To save a grape crop from rot I would suggest that after pruning, the vineyard be disinfected by the removal and burying of its decidua—every rotted berry or mildewed leaf should be destroyed or buried and not disturbed during the growing season. This, as I have stated in my address to the National Viticultural Convention, is important, and will aid subsequent prophylactic intervention against the fungus. I have thousands of vines, which this year have been unprotected by treatment, except by the disinfection advised. The grapes they bear are badly rotted, but not nearly so badly as in vineyards in the vicinity where this disinfection was neglected. The vines carry part of a crop—worth harvesting for the vintage—while on vineyards not thus disinfected there is nothing.

After the vineyard is cleaned and put in order with the plow and smoothing harrow, spray, wash, or sponge the vines with Bordeaux mixture early in the spring, before vegetation starts. Then, when the clusters are formed, and before blooming, spray the vines *and the clusters* again. Repeat this treatment once in two weeks until the fruit begins to color.

With an efficient spraying-pump and the cyclone or Riley nozzle, it is easy at any time during the season of growth to give every cluster a wetting with the rot preventive. This cyclone nozzle may be thrust in among the leaves where they are thickest, and it will still diffuse its spray.

PREPARATION OF BORDEAUX MIXTURE.

The Bordeaux mixture is best made by having the crystals of copper sulphate pulverized; then dissolve them in boiling hot water—say 2 gallons water to 6 pounds of the sulphate.

A quantity of fresh lime is slaked, as the masons slake it for mortar, then strained into a box and left to settle and thicken. The proportions indicated by the formula may then be combined as needed for use.

It is needless to waste time with any of the other combinations of copper, unless it be with the solution of ammoniacal carbonate. My experience with this is satisfactory. It adheres well to the foliage, and as a preventive of mildew is the equal of any of the preparations used. As to its efficacy as a preventive of black-rot I have no knowledge, as the section to which it was applied was doubtless infected before spraying (June 18.)

The solution of carbonate of copper is quickly prepared. Pour 1 quart of liquid ammonia upon 3 ounces carbonate of copper; stir the mixture a minute and then dilute with 22 gallons of water.

The Department circular states that "the concentrated liquids, of ammonia and the carbonate, may be prepared and kept indefinitely." I find that when the concentrated solution is kept for some days it deposits crystals on the sides of the containing vessel. It may thus lose some of its virtues. It is so easily and quickly prepared that there is no need of making the solution in advance.

It has been stated that one formula of eau celeste burned the foliage because of the sulphate of ammonia in it. In making the solution it is advised to dilute this with several gallons water, let stand till the copper precipitates, then pour off the superincumbent liquid, which carries with it the sulphate of ammonia, and redissolve the precipitate in more ammonia.

I tried this; drained off the liquid and filled my spraying machine with it. Then, with this solution of sulphate of ammonia I drenched some grape-vines, a row of strawberry plants, and various other vegetables. The foliage of none of these plants was burned. I fancy that the burning is caused by the acid in the copper sulphate. The simple solution of copper sulphate and water burns the foliage worse than any of the mixtures. This season I tried a solution of 1 pint sulphuric acid and 1 pound of glycerine to 20 gallons of water; it scorched every leaf it touched. I then diluted this with 20 gallons more of water. It still scorched the foliage. Then I added to it 4 pounds of lime. It then does no harm, and I find it preventive of mildew and rot.

To learn whether the grape blossom is always self-fertilizing, I applied paper bags upon the clusters of several varieties before they were in bloom. Those sorts which have reflexed stamens did not fertilize their ovules when bagged; but this season the same varieties failed to fertilize perfectly when not bagged.

This experiment led to interesting observations concerning grape-rot.

In a vineyard untreated by rot-preventives I applied several thousand grape-bags, beginning before the grapes bloomed. To successive rows of Concords I put on two hundred bags every day (dating the bags), and continuing until grape-rot appeared epidemically. When Professor Scribner visited me, July 30, we inspected these bagged rows. In the bags applied on or before June 22 we found the grapes generally free from black-rot. Those bagged on June 23 and subsequently were badly rotted.

This experiment indicates that the invasion of the disease occurred seriously *after* the morning of June 22, when the bags for that day were applied, and *before* the morning of June 23 when the bags for that day were put on.

On the afternoon of June 23 there was a thunder-storm and slight spatter of rain. If this rain had come *before* the grapes were bagged, on June 23, the invasion of the rot might be accounted for at that date through the supervention of the rain; but the grapes were bagged in the morning, during intense heat and drought, and the rain was not until afternoon.

Extended inspection of these bagged grapes, made recently, discovers the interesting fact that the infection of black-rot enters the grape before it blossoms. The clusters bagged thus early are generally safe from rot, but there is occasionally seen in them one or two berries destroyed by the first invasion of the fungus. There is just enough of this evidence to prove that the infection occurred as stated.

After removing some bags from grape clusters, on August 1, I tried to see if these might be protected from rot during the rest of the season by an application of Bordeaux mixture, on August 4.

It was raining at the time the bags were taken off the clusters, on August 1. A few rotted grapes appeared on these clusters on August 12.

I then took the bags from many clusters and sprayed these immediately with the Bordeaux mixture. At the same time I left some clusters (from which the bags were removed) unsprayed. The latter showed in a few days the spots indicative of infection by the rot germs; the former remained healthy until they ripened.

On July 25 I received instructions from the Department to test the effect of the copper sulphate solutions upon the foliage of the apple trees. I did so; also including the pear, the cherry, and the quince.

I used eau celeste, made per original formula; the modified eau celeste, prepared with soda; the Bordeaux mixture, and the solution of copper carbonate. I could detect no injury to the foliage from any of these applications, and judge that when the acid of the sulphate is fully neutralized neither of these solutions will harm even tender sorts of plants.

In the case, however, of the Æstivalis and Riparia families of the grape, it will be well to use the copper solutions cautiously. Experience will be a safe guide: first try a few vines and wait a few days to note the effects.

I tested, to some extent, the Bordeaux mixture and the solution of copper carbonate upon the potato blight, tomato blight, melon-leaf blight, and mildew of the pea-vine with good results, and am very confident that by these means these plant maladies may be effectually remedied or prevented.

Very respectfully,

ALEX. W. PEARSON.

Hon. J. M. RUSK,
Secretary of Agriculture.

EXPERIMENTS MADE AT CHARLOTTESVILLE, VA. (SEASON OF 1888).

SIR: I have the honor to submit the following report of experiments in the treatment of mildew and black-rot of the grape-vine, made in accordance with letters of instruction from your Department, and of an experiment in the treatment of anthracnose, as recommended by the congress on parasitic diseases of the vine, held at Florence, Italy, October, 1886, and contained in the Botanical Division Bulletin, No. 2.

I would first state that in my pruning and cleansing work, done during the dormant (winter) season, I was particular to have the leaves, grass, and all trash raked to the center of the rows and burnt.

ANTHRACNOSE.

I determined to make an experiment for the prevention of anthracnose, because of the great amount of damage done by it in 1886 and 1887 to my Elvira and Delaware vines, and also because of its prevalence amongst other varieties grown in the neighborhood. The formula used was that of a saturated solution of sulphate of iron, which was applied during the latter part of February and in the following manner:

Cheap, coarse sponges were wired to the ends of round sticks of 15 inches in length; and buckets were used having a spatter strip nailed across the top. The sponge was immersed in the liquid, withdrawn, struck against the spatter-strip to save waste, and the vine then washed thoroughly from the base to the free ends. Five hundred and fifty vines were thus treated and fifty were left untreated. The entire absence of this fungus amongst the treated vines led me to believe that the effects of this application were most satisfactory. In the untreated rows the Elvira suffered a loss of from 20 to 25 per cent. of fruit, and a corresponding depreciation of vitality of the vines, while the Delaware (which is also so subject to mildew) did not give any grapes worth mentioning, and made a very inferior growth of cane.

MILDEW AND BLACK-ROT.

Nine different preparations were employed in experiments made for the prevention of these fungi, viz:

Sulphatine.

Copper mixture of Gironde (Bordeaux mixture), in two degrees of strength.

Blue-water or *eau celeste*, in two degrees of strength.
First and second formulas of M. Masson.
Formula of M. G. Perboyre.
Formula of M. Gastine.

SULPHATINE TREATMENT.

The sulphatine was purchased ready for use, and was applied first on the 11th of May after rain and during cloudy weather, which continued for three days thereafter. The second application was made May 31, after a fall of rain and during cloudy weather, which continued for the two following days. The third application was made June 22, and the vines were first sprayed with water (using the Vermorel nozzle) in order to secure the thorough adherence of the powder. The fourth application was made July 20, after a fall of rain, and during cloudy weather, which continued for the remainder of that day. The total amount applied was 40 pounds. The instrument used was the Lagleyze bellows furnished by your Department, which is fully described and illustrated in Bulletin No. 5 of the Botanical Division. It did very satisfactory work in that it admitted of directing and controlling the quantity of material used, and of making an extended application without waste of labor, as compared with such other instruments of this kind as I have tried. The varieties treated were Wilding, Etta, Grein's Golden, Missouri Riesling, Uhland, Empire State, Lutie, Triumph, Marion, Rebecca, and Montifiore. Total number of vines, one hundred and forty-two. The grapes of this section when gathered showed a loss of about 15 per cent. from black-rot, but there was no evidence of mildew, while the vines left untreated for control experiment showed 25 to 30 per cent. of black-rot, and much mildew in places. I believe all powdery applications are more wasteful and also more expensive in the items of labor and quantity; neither are they as efficacious as the liquid remedies.

COPPER MIXTURE OF GIRONDE, FIRST FORMULA.

This was prepared by dissolving 8 pounds of sulphate of copper in 15 gallons of warm water, and slaking 10 pounds of lime in 5 gallons of water, and mixing the two when cooled. This preparation was applied first May 11, after a rain, during cloudy weather, which continued for three days. The second application was made June 2, during damp and cloudy weather, which continued for a day. The third application was made on July 5, during cloudy weather; no further application seemed necessary.

The varieties treated were Roger's Hybrids, Rickett's and Grein's Seedlings, Concord, Moore's Early, Cottage, Worden, Delaware, Lady Pocklington, Jefferson, Montgomery, Ives, Hartford, Wyoming Red, Vergennes, Duchess, Prentiss, and Martha. Total number of vines treated, one hundred and thirty-eight. The grapes of this section when gathered showed a loss of from 5 to 10 per cent. from black-rot, while the untreated vines showed a total loss in some instances, and an average loss of from 60 to 65 per cent. The treated vines showed an entire exemption from mildew, while those untreated presented a condition which caused me greatly to regret the necessity of having to leave them for experiment purposes, as some of my best table varieties were the sufferers.

COPPER MIXTURE OF GIRONDE, SECOND FORMULA.

This was prepared by dissolving 6 pounds of sulphate of copper in 15 gallons of warm water, and slaking 4 pounds of lump lime in 5 gallons of water, and mixing the two when cooled. This preparation was applied first May 12, during damp and cloudy weather, which continued for two days thereafter. The second application was made June 2, during damp and cloudy weather, which continued for a day. The third application was made July 5, during cloudy weather. No further application seemed necessary. Had this section received no treatment in 1887, I am of the opinion that it would have required the stronger preparation or one, and perhaps two more applications of this one to have given the best results. The variety treated was Champion. The total number of vines treated was one hundred and forty-three.

The grapes of this section when gathered showed a loss of from 10 to 12 per cent. from black-rot, while the untreated vines showed a loss of about 33⅓ per cent. No mildew whatever appeared on the vines in the treated section and but little in the untreated rows.

EAU CELESTE, FIRST FORMULA.

This was prepared by dissolving 1 pound of sulphate of copper in a gallon of hot water, to which was added (a little at a time) sufficient liquid commercial ammonia to precipitate all the copper; then 3 gallons of water was added and the whole allowed to settle. The clear liquid at the top containing the sulphate of ammonia (the compound which caused the burning of the leaves) was then poured off and just enough liquid ammonia was poured upon the precipitate left in the barrel to dissolve it. The result was a clear liquid of a deep blue color. This was diluted with water to make 22 gallons.

This preparation was first applied May 18, during cloudy weather, which continued for two days. The second application was made late in the afternoon of June 5, during dry and clear weather. The third application was made June 22, during cloudy weather, and the fourth was made July 13, during moist and cloudy weather.

The varieties treated were Catawba, Elvira, Bacchus, Gœthe, Delaware, Lindley, Lady Washington, Salem, and Martha. The total number of vines treated was one hundred and forty-two.

Unlike the results attending the application of eau celeste in 1887, there was no damage to or burning of foliage this year.

The grapes of this section when gathered showed a loss from black-rot of not more than 5 per cent., while the untreated rows, containing varieties peculiarly subject to rot and mildew, lost from 33⅓ to 50 per cent. The treated varieties were in fine form, while the untreated were much injured by mildew.

EAU CELESTE, SECOND FORMULA.

This was prepared in the same manner as the first formula except that the dilution with water was increased to 44 gallons.

This preparation was applied first May 18, during cloudy weather, which continued for two days. The second application was made late in the afternoon of June 5, during dry and clear weather. The third application was made June 22, during cloudy weather. The fourth was made July 13, during moist and cloudy weather. A fifth application was made August 9, during cloudy weather and after several successive days of heat, accompanied by a heavy rain. This, however, was applied to the Norton's Virginia only, as the fruit of the others was ripe on the vines.

The varieties treated were Cottage, Lindley, Black Eagle, and Norton's Virginia. The total number treated was two hundred and seventy-three.

The grapes of this section when gathered showed from 10 to 15 per cent. loss from black rot, while the untreated rows showed a loss of 40 to 45 per cent. from this cause. There was a slight start of mildew after the third, also after the fourth application, which caused me to make the fifth application to the variety whose grapes were not within two or three weeks of harvest. The untreated rows developed mildew to a ruinous extent.

M. G. PERBOYRE FORMULA.

This was prepared as follows, viz: In one vessel dissolve 2 pounds of sulphate of copper in a gallon of water. In another vessel dissolve 1 pound of carbonate of soda in a gallon of water. Mix the two solutions and dilute to 44 gallons.

This preparation was first applied May 21 during clear weather, but followed by two days of rain, in which 1.4 inches fell. The second application was made June 5, during clear weather. The third application was made June 22, during moist and cloudy weather. The fourth and last application was made July 10, during moist and cloudy weather.

The variety treated was Norton's Virginia. The total number of vines treated was two hundred and eighty-two.

The grapes of this section when gathered were in fine condition, with but from 5 to 8 per cent. of rot, and no mildew, while the untreated rows showed from 15 to 20 per cent. of rot and considerable mildew.

M. MASSON, FIRST FORMULA.

This was prepared as follows, viz: Dissolve 2 pounds of sulphate of copper in 2 or 3 gallons of hot water, and while the solution is yet warm add 2 pounds of carbonate of soda, a little at a time. When required for use dilute with water to 22 gallons.

This preparation was first applied May 21, during clear weather, which was followed by two days of rain in which 1.4 inches fell. The second application was made June 5, during clear weather. The third application June 22, during moist and cloudy weather. The fourth and last was made July 10, during moist and cloudy weather.

The variety treated was Norton's Virginia. The total number of vines treated was one hundred and thirty-nine.

The grapes of this section when gathered showed from 3 to 5 per cent. of rot, and were free from mildew. The untreated rows showed from 15 to 20 per cent. of rot and some mildew.

M. MASSON, SECOND FORMULA.

This was prepared as follows, viz: Dissolve 4 pounds of sulphate of copper in 2 or 3 gallons of hot water, and while the solution is yet warm add 2 pounds of carbonate of soda, a little at a time. When required for use dilute with water to 22 gallons.

This preparation was first applied May 21, during clear weather, which was followed by two days of rain, in which 1.4 inches fell. The second application was made June 5, during clear weather. The third application June 22, during moist and cloudy weather. The fourth and last was made July 10, during moist and cloudy weather. The variety treated was Norton's Virginia. The total number of vines treated was one hundred and forty-five.

The grapes of this section when gathered were in the same condition in the treated and untreated rows as those under the first (preceding) formula, with this exception: a dropping of the foliage was observable at the time of the second application, and the leaves fell some ten days or two weeks earlier. The condition of the wood at the close of the season was good.

AMMONIACAL CARBONATE OF COPPER SOLUTION, PROPOSED BY M. GASTINE.

This was prepared as follows, viz: In a 2-quart bottle, furnished with a close-fitting stopper, put 1 quart of liquid ammonia and 3 ounces of carbonate of copper. Shake well, and the copper carbonate will dissolve in the ammonia, forming a liquid of a beautiful deep-blue color. When required for use dilute to 22 gallons.

This preparation was first applied May 30 (too late), during moist and cloudy weather. The second application was made June 18, immediately after a rain. The third application was made July 10, immediately after a rain.

The variety treated was Catawba. The number of vines treated was one hundred and thirty-seven.

The grapes of this section when gathered showed from 20 to 25 per cent. of rot, but no mildew. The untreated rows showed from 50 to 60 per cent. of rot and considerable mildew.

The Catawba has been ravaged in certain localities to greater extent by mildew and rot than any other variety, and this must be taken into consideration in judging of the results of this experiment.

Not having been advised until May 17 of this and two other formulas suggested by M. Gastine, and having met with some unavoidable delay in procuring the preparation, I was unable to make this experiment as early as needed to procure the best results. I am, however, convinced that the extreme ease of preparation, perfect adherence (even greater than that of eau celeste), and the comparative economy of the preparation, are three points in its favor. I look forward to the season of 1889 for the opportunity of thoroughly testing the formula proposed by M. Gastine.

Floresence began May 18 in the early-blooming varieties.

Mildew (fully developed) was first seen May 27.

Rot first appeared in the Labrusca and Vinifera Hybrids June 11; in Norton's Virginia June 28. It continued to increase until August 9.

By comparing with last year's record it will be seen that mildew was four days earlier in 1888, while rot appeared seven days later.

The difference in quantity of fruit and quality of must between my treated and untreated Norton's Virginia variety was so marked at the wine cellar as to call forth the following communication:

> CHARLOTTESVILLE, VA.
>
> In receiving grapes from H. L. Lyman, delivered to and bought by the Monticello Wine Company in September and October, 1888, we found a very marked difference in the Norton grapes treated for mildew and rot by the application of bluestone mixtures from those not so treated. This difference was shown not only in a much less degree of rot but more in the *quality*, as indicated by the saccharometer. Those treated were rich in sugar, and consequently of increased value of one-half a cent per pound, *i. e.*, $10 per ton increase.
>
> OSCAR RIERSON, *Secretary.*

In comparing the preparations it is my opinion that no powdery form is as desirable, economical, or efficient as the liquid, even granting the mechanical conditions to be perfect (which would not generally be the case).

The Vermorel sprayer was used during the fore part of the season, and Weaber's Eureka sprayer for the remainder.

I submit herewith the meteorological report of May, June, July, August, September, and October, 1888.

I am convinced that in every case treatment with a weak solution should be begun before the blooming season, and the strength of the preparation increased with the development of strength in the vine.

ADVANTAGE OF TREATMENT.

(1) Fruit saved.

(2) Fruit ripened up to the standard.

(3) Good wood for succeeding season.

(4) Diminished infection for succeeding year.

In view of these advantages the expense of any remedy should deter no one from its application.

COST (HERE).

Lime $1.10 per barrel; liquid ammonia 50 cents per gallon; sulphate of copper 5½ cents per pound; carbonate of soda 2 cents per pound. Cost of preparation and expense of application the same as reported by me last year.

Respectfully,

H. L. LYMAN.

Hon. J. M. RUSK,

Secretary of Agriculture.

Meteorological report.

Day.		Weather.	Daily mean temperature.	Daily mean relative humidity.	Barometer reduced to 32° Fahrenheit at sea level.	Maximum temperature.	Prevailing wind.	Minimum temperature.	Rain-fall.
May	1	Clear and cloudy	75	44	29.840	86	NW	64	0
	2	......do	56	46.5	30.082	65	NNW	47	0
	3	......do	51.5	58.5	29.966	65	S	38	0
	4	......do	61.5	80	30.128	72	S	51	0
	5	......do	70	52.5	30.049	83	NWW	57	.31
	6	......do	74	39	30.235	82	S	66	0
	7	......do	66.5	57	30.208	83	S	50	0
	8	Cloudy and raining	67	100	30.167	77	NW	57	1.18
	9	......do	67.5	94	30.024	77	S	58	1.25
	10	......do	67.5	92.5	29.934	73	S	62	.47
	11	Raining and cloudy	64.5	95	29.865	69	NE	60	.16
	12	Cloudy	71	81	29.777	81	S	61	.42
	13	Cloudy and clear	62.5	52.5	29.380	70	NW., SE	55	.10
	14	Cloudy	57	66.5	29.865	70	NW., SE	41	0
	15	Clear	53.7	47.5	30.033	63.5	NW	44	0
	16	Cloudy and clear	54	70	30.039	63	NW	45	0
	17	Clear	52	67	30.201	65	NNE	39	0
	18	Raining and clear	62	93	29.980	73	SE	51	.25
	19	Cloudy	67	77	30.017	74	NE	60	.04
	20	......do	59	66	30.262	68	NE	59	0
	21	Clear	53	78.5	30.228	62	NE	44	0
	22	Raining	50	89.5	30.136	56	N	44	1.00
	23	......do	53.5	97	29.411	61	NE	46	.40
	24	Cloudy and clear	62.5	87	29.909	71	NE	54	.04
	25	Cloudy	62.5	92	29.942	68	E	57	.10
	26	Clear	69	64.5	29.925	79	SE	59	.13
	27	Murky and cloudy	68.5	80.5	29.879	83	SE	54	0
	28	Murky and clear	75.5	65	29.811	90	SE	61	.03
	29	Clear	78.2	53.5	29.898	88.5	SW	63	0
	30	Clear and cloudy	75	75	29.964	85	SE	65	.04
	31	Rainy	68.5	95	29.853	72	E	65	.36
		Total	....	....	....	....	....	....	6.28
June	1	Clear and raining	65.7	72	29.882	78.5	NSE	53	.30
	2	Clear	61.5	68	29.963	71	NW	52	.41
	3	......do	61.5	63	30.145	69	N	54	0
	4	......do	60	59.5	30.254	75	N	45	0
	5	......do	64	62	30.404	81	SE	47	0
	6	......do	72	62	30.188	88	SW	56	0
	7	......do	73	65.5	30.053	88	NW	68	0
	8	......do	64.5	69	30.122	79	N	50	0
	9	......do	65.7	67.5	30.101	80.5	SW	51	0
	10	Clear and raining	73.7	90	29.490	87.5	SE	60	.15
	11	Clear and cloudy	72.5	68.5	29.880	81	NW	65	0
	12	Clear	63	54	30.169	77	NE	49	0
	13	......do	62.5	66	30.307	75	SW	59	0
	14	......do	74	70	30.039	87	SE	61	0
	15	......do	75.7	64.5	29.988	90.5	W	61	0
	16	......do	79.5	63.5	29.903	93	NW	66	0
	17	......do	77	65	29.934	89	NW	65	0
	18	Raining and clear	79.5	49	29.845	95	NW	64	.66

Meteorological report—Continued.

Day.	Weather.	Daily mean temperature.	Daily mean relative humidity.	Barometer reduced to 32° Fahrenheit at sea level.	Maximum temperature.	Prevailing wind.	Minimum temperature.	Rain-fall.
June 19	Clear	81.2	61	29.919	92.5	NE	70	0
20	do	77	74	29.925	89	SW	65	0
21	do	80.5	67	29.869	94	SW	67	0
22	Clear and cloudy	80	69	29.646	92	NW	68	.25
23	do	80.2	74.5	29.836	92.5	NW	68	0
24	do	80.2	83.5	29.858	92.5	NW	68	.03
25	Clear	78.5	59	29.856	89	N	68	0
26	do	76	63	29.858	87	NW	65	0
27	Clear and cloudy	75	76	30.000	85	NE	65	.25
28	Cloudy	76	78.5	29.774	85	NE	67	.86
29	do	69.5	84	30.088	81	NE	58	.95
30	Clear	68.5	81.5	30.076	80	S	57	0
	Total							3.86
July 1	Clear	72.5	69.5	29.990	83	NW	76	0
2	do	64.5	62	30.179	77	N	52	0
3	do	69.5	70.5	30.281	80	SE	54	0
4	Clear and cloudy	79	73	30.114	83	SSE	75	0
5	do	79	79	29.982	90	NE	68	.38
6	Clear	77.5	56.5	30.104	87.5	W	68	0
7	Clear and Cloudy	79.5	62.5	30.019	94	SW	65	0
8	Cloudy	80.2	71	30.067	87	NE	73	.11
9	do	77.7	87	29.915	87.5	SW	68	.41
10	Raining and cloudy	71	90.5	29.938	82	N	60	.37
11	Clear	73	79	29.974	88	NW	58	0
12	do	79	86	29.786	90	SE	68	0
13	Clear and cloudy	73.5	76.5	29.945	87	NW	60	.40
14	Clear	66.5	60.5	30.108	79	NW	54	0
15	do	67.5	71.5	30.112	82	N	53	0
16	do	68.7	59.5	30.121	83.5	SE	54	0
17	do	70	55	30.206	80	SE	69	0
18	do	71.2	70	30.224	82.5	SW	60	0
19	Clear and raining	71.2	86	31.020	75.5	SE	67	.43
20	Clear	76	78	30.024	85	SE	67	.05
21	do	73.5	28.5	30.118	79	NE	68	0
22	do	82	14.5	30.107	85	NE	69	0
23	do	78.5	14.5	30.240	87	W	70	0
24	do	76.5	74.5	30.058	93	NW	60	.30
25	do	71	52.5	30.124	83	NW	59	0
26	do	68.5	63.5	30.122	82	SE	55	0
27	do	74.5	67	30.001	88	SE	61	0
28	do	71	69.5	30.120	82	NE	60	.13
29	Cloudy	72.5	74.5	30.259	80	SE	65	0
30	do	69.2	90.5	30.141	74.5	SE	64	.90
31	Clear	75.7	81	30.032	84.5	S	67	0
	Total							3.08
Aug.* 1	Clear and raining	79.5		29.905	86	S	68	.07
2	Clear	78.5		29.950	85	NE	72	0
3	do	77.5		29.905	87	E	68	0
4	do	83.0		29.760	93	SE	73	0
5	Clear and raining	81.0		29.730	86	NE	76	.05
6	Cloudy and raining	80.5		29.810	88	Calm	73	.48
7	Clear	81.5		29.850	90	Calm	73	0
8	do	83.5		29.855	91	Calm	76	0
9	Clear and cloudy	76.5		29.855	83	SE	70	.03
10	Cloudy	73.0		29.950	78	NEE	68	.09
11	do	72.0		30.130	81	SE	63	0
12	Cloudy and raining	74.5		30.130	82	SW	67	.61
13	Clear	71.5		29.965	75	N	68	0
14	do	68.0		29.950	79	NW	57	0
15	do	76.5		29.930	85	SW	68	0
16	do	81.0		30.000	89	SW	73	0
17	Clear and cloudy	79.5		30.005	87	SW	72	.13
18	Cloudy and raining	85.0		29.945	94	SW	76	.38
19	do	79.5		29.970	79	NE	72	.41
20	Cloudy	75.0		29.970	80	NE	70	.09
21	Cloudy and raining	80.5		29.905	79	SE	72	.17
22	Raining	73.0		29.555	78	SW., NE	68	1.49
23	Clear	63.0		29.865	71	NW	55	0
24	do	66.0		30.070	77	SW	55	0
25	do	66.5		30.000	78	SW	55	0
26	do	70.0		29.975	81	SE	59	0

*Humidity not obtained for this month.

Meteorological report—Continued.

Day.	Weather.	Daily mean temperature.	Daily mean relative humidity.	Barometer reduced to 32° Fahrenheit at sea level.	Maximum temperature.	Prevailing wind.	Minimum temperature.	Rain-fall.
Aug. 27	Clear and cloudy	72.5		29.955	77	SW	68	.13
28	Clear	67.0		29.885	71	NE	63	0
29	do	66.0		29.945	76	SW	56	0
30	do	74.5		29.850	85	SW	64	0
31	Cloudy and raining	73.0		29.845	80	SE	66	.27
	Total							4.40
Sept.* 1	Clear and raining	76.5		29.790	82	SW	71	.11
2	Clear	70.5		30.015	78	NE	63	0
3	Raining	65.5		30.060	67	NE	64	.27
4	Clear	68.0		29.960	75	Calm	61	0
5	Cloudy and raining	72.0		29.995	79	E	65	.39
6	do	59.0		30.250	60	NE	58	.93
7	do	56.0		30.255	59	NE	53	1.81
8	do	62.5		30.035	73	NE	52	2.49
9	do	70.5		29.835	77	SE	64	.63
10	do	70.0		29.845	72	NE	68	1.79
11	do	62.0		29.845	66	NW	58	1.58
12	Clear	67.5		29.880	78	SW	57	0
13	do	69.0		29.900	77	NE	61	0
14	do	62.0		30.070	68	E	56	0
15	Clear and raining	65.0		29.995	69	NE	61	.07
16	Cloudy and raining	70.0		29.755	76	SE	64	.40
17	Raining	71.5		29.810	74	SW	69	2.05
18	Clear	70.5		29.955	77	Calm	64	.48
19	do	70.0		30.010	75	Calm	65	0
20	Clear and cloudy	68.5		29.970	76	SE	61	0
21	Clear	79.0		29.900	76	NE	64	0
22	do	67.0		29.995	71	Calm	63	0
23	do	61.5		30.005	67	NE	56	0
24	Cloudy and clear	60.0		30.000	62	NE	58	0
25	do	56.5		29.765	58	N	55	.10
26	Clear	58.0		29.575	70	SW	46	0
27	do	61.5		29.725	72	SW	51	0
28	do	55.5		29.920	63	NW	48	0
29	do	50.0		29.980	56	NW	44	0
30	Light frost	47.7		29.885	57	W	38	0
	Total							13.10
Oct.* 1	Clear and cloudy	56.0		29.745	68	SW	44	0
2	do	63.5		29.510	68	SW	59	0
3	do	51.5		29.910	57	NE	46	0
4	White frost	49.0		30.100	61	Calm	37	0
5	Clear	57.5		29.875	69	SE	46	0
6	Raining and clear	62.0		29.815	68	S	56	.18
7	Clear	58.5		29.705	66	SW	51	0
8	do	59.0		29.530	64	SW	54	0
9	do	50.5		29.725	56	NW	45	0
10	Sharp frost	46.5		29.940	58	SW	35	0
11	Rain	46.5		29.830	48	NE	45	.45
12	Clear and cloudy	48.5		29.490	55	SW	42	.05
13	Clear	52.0		29.560	59	SW	45	0
14	do	52.5		29.780	57	SW	48	0
15	Clear and showers	51.0		29.920	59	SW	43	.07
16	Clear	55.55		29.845	63	SW	48	0
17	do	60.5		29.925	67	SW	54	0
18	White frost	52.0		30.150	61	NW	43	0
19	Clear and cloudy	60.5		30 005	73	SW	48	.08
20	Clear	59.5		29.795	62	SW	57	0
21	White frost	47.5		30.095	55	NW	40	0
22	White frost and light shower	45.0		30.250	53	SW	37	.09
23	Raining	54.0		30.000	60	Calm	48	.52
24	Clear	58.5		29.850	64	NW	53	0
25	Clear and misty	51.5		30.110	60	SW	43	.11
26	Rain	51.5		30.200	53	NE	50	1.29
27	Misty and clear	56.0		29.865	62	NE	50	.39
28	do	56.0		29.770	62	SW	50	.21
29	Clear	52.5		29.880	60	SW	45	0
30	do	50.5		30.070	60	NE	41	0
31	do	51.0		30.145	63	SW	39	0
	Total							3.44

* Humidity not obtained for this month.

EXPERIMENTS AT NEOSHO, MO. (SEASON 1888.)

SIR: I have the honor to submit the following report of experiments made by me under the direction of your Department:

DAILY NOTES.

May 1 *to* 10.—Made applications, in various vineyards, with eau celeste, Bordeaux mixture, and sulphatine.

May 17 *to* 22.—Same treatment given to latest starting varieties as well as to my young vineyard and nursery vines.

June 4 *to* 10.—Made second application on all vines except test rows. For this treatment used eau celeste with addition of bicarbonate of soda, also carbonate of copper dissolved in ammonia. Up to June 6 the spring has been about an average one; rather drier than usual. From June 6 to 10 we had nearly 4 inches of rain.

June 8.—I found a few spots of black-rot on foliage of treated and untreated vines for first time, but decidedly more on those not treated.

June 9 *and* 10.—While spraying vines, noted black-rot on foliage; more frequent on untreated test rows. Also find on the 10th first spots of mildew on leaves of untreated Delawares and some varieties of Lincecumii. On the afternoon of June 11 I also discovered the first specks of black-rot on fruit of untreated Concord and North Carolina vines.

June 12 *to* 15.—Treated all bearing vines, except test rows, with same remedies as before, being particular about spraying fruit thoroughly.

June 18.—Made a careful examination and found mildew and black-rot more frequent on foliage. Mildew occurs exclusively on untreated vines, and mostly on Delaware, Elvira, Uhland, Black Pearl, etc. Black-rot on foliage occurs on every species and on both treated and untreated vines, but is a great deal more abundant on the latter.

As to black-rot on fruit I find the few berries spotted on the 11th now fully destroyed. Besides, a few other berries are diseased on almost all untreated varieties.

I passed this whole day (June 18) searching several acres of sprayed vines for rotten berries and picked out about 1 pint of such. From June 18 to 23 we had over 8 inches of rain.

June 23.—I commenced another treatment of the whole vineyard, beginning with bearing vines and finishing with young vineyard and nursery at the end of the month.

June 25 and following days I observed a new and intense attack of rot, commencing on untreated Concords and gradually spreading over the whole vineyard, attacking treated and untreated rows, but again damaging the fruit of the latter by far the most.

July 1.—*Made a thorough examination of all grapes and find that Martha, Concord, North Carolina, Telegraph, Gœthe and other Labruscas and European hybrids have from* 30 *to* 40 *per cent. of their fruit destroyed by black-rot on all untreated vines. Same varieties treated with eau celeste show from* 20 *to* 30 *per cent. of rot, and treated with Bordeaux mixture hardly* 15 *per cent. Ten vines of Concord thoroughly sprayed with Bordeaux mixture June* 23, *have not lost over* 5 *to* 10 *per cent. of their fruit by rot.*

Delawares treated with Bordeaux mixture the same day have but few rotten berries. Those treated with eau celeste have lost about 10 per cent., while on untreated Delawares full 20 per cent. of the fruit is destroyed by black-rot, and the foliage is considerably injured by mildew.

Elvira, Elvira Seedling No. 100, Missouri Riesling, Perkins, and Ives, all have but very little rot; in fact the Elvira treated with Bordeaux mixture is throughout practically absolutely free of it.

Norton is about perfect in foliage and fruit on both treated and untreated vines.

July 12 *to* 15.—Treated nursery rows with sulphatine and my young vineyard with eau celeste. Plants from seed of *V. Berlandieri* and Japanese vines show considerable mildew on new leaves while the older leaves that were treated before remain quite healthy.

August 1.—Examined again all vines. Black-rot has undoubtedly increased during July, although for the last ten days I have noticed no spreading of the disease. The following table prepared from August 2 to 10 (before gathering earliest grapes), gives estimate of black-rot on various varieties under different treatments:

Variety.	Per cent. destroyed by black-rot.			Variety.	Per cent. destroyed by black-rot.		
	No treatment.	Eau celeste.	Bordeaux mixture.		No treatment.	Eau celeste.	Bordeau mixture.
Perkins	1	1	0.5	Noah	30	....	15
Ives	2	1.5	1	Missouri-Riesling	0.5	0.4	0.2
Martha	40	30	26	Hermann	40	30	25
Concord	50	35	25	Norton	0.4	0.3	0.1
Catawba	55	40	35	Neosho	5	4	2
Telegraph	65	55	....	Lincecumii No. 9	75	....	....
North Carolina	75	70	65	Racine	60	50	40
Delaware	30	18	3	Lincecumii Nos. 13, 4	0	0	0
Herbemont	75	....	70	Æstivalis Rupestris, 70	2	2	1
Gœthe	70	60	60	Rupestris type	0	0	0
Elvira	0.8	0.6	0.3				
Uhland	20	15	....	Average per cent.	31.6	18.7	16.3

August 25 to 30.—Treated all vines as before.

September 5 to 10.—Examined vineyards again. The earlier varieties are nearly all gathered, and late grapes of the Æstivalis species are about the only ones left for comparison. Of these the main crop, consisting of treated and untreated Norton's is quite as sound as when observed a month ago.

Æstivalis (type Lincecumii) Nos. 13 and 43 and Neosho also remain unchanged on treated and untreated vines. On other varieties, being very liable to rot, the disease has increased 5 to 15 per cent. since August 10, wherever vines were left untreated, notwithstanding the small rain fall (scarcely 2 inches) during the last thirty days.

The same rotting varieties of Æstivalis, viz, Herbemont, Louisiana, Hermann, Racine, Lincecumii Nos. 9, 32, and others, show very little or no increase of black-rot during the last month, wherever well treated with eau celeste or Bordeaux mixture.

By referring to above table, it will be seen that the last-mentioned Æstivalis vines suffered about as badly here as any Labrusca or Fox grape. Nor is this an exception; it agrees with many years' experience of others as well as myself in this locality.

It seems to me, though (and in this assertion I am as positive as possible without microscopic investigation), that white-rot (*Coniothyrium diplodiella*) attacks oftener these rotting Æstivalis grapes than it does Labruscas; while it is undoubtedly correct that on all kinds of grapes black-rot occurs much more frequently here than white rot.

September 16 *to* 20.—Made last treatment; weather continuing very dry, I applied copper remedies this time only to young vineyard and nursery and to the bearing vines most liable to mildew, viz, Delaware, Elvira, Uhland, Noah, Clinton, Black Pearl, and some European hybrids.

September 30.—Grapes being about all gathered, I have to-day compared state of foliage and wood on treated with untreated vines. The season, it must be remembered, was a very dry one here, from the latter part of June until now. Therefore the attacks of mildew were not nearly as intense as during the last disastrous season (1887).

The most resistant vines, such as Ives, Concord, Perkins, Norton, and others remained practically free from *Peronospora*, even on vines not treated, yet, at this date (September 30), the foliage even of these resistant vines shows a decidedly fresher, brighter green where sprayed than on untreated plants of same kind. A neighbor's untreated Norton vineyard and my own Nortons, viewed from a distance, did not seem to be the same vines, because the untreated Nortons have a much more yellowish shade of green.

Gœthe, Catawba, Missouri Riesling, and Elvira No. 100 have lost some 20 per cent. of their foliage on untreated vines. Elvira, Noah, Uhland, Black Pearl, Clinton, from 40 to 60 per cent., and untreated Delawares from 70 to 90 per cent. The same varieties treated with eau celeste and Bordeaux mixture have perfectly green and healthy leaves. So have Elviras, sprayed with eau celeste first and later with ammoniacal solution of carbonate of copper, while the vines dusted with sulphatine show considerable difference. Few of these dusted vines only have as perfect foliage as those sprayed with liquid remedies, yet all of them preserved more and healthier leaves than same varieties left without treatment.

For experienced vine growers it is unnecessary to add that on all vines the amount of well grown and thoroughly matured wood corresponds with the health and development of their foliage.

About the middle of October we had the first frost hard enough to defoliate all Labrusca and Æstivalis vines, yet not sufficiently severe to kill the hardier green growth of Riparia and Rupestris. Thus, for the next two weeks my sprayed Elvira vines kept their green leaves, while formerly, even in good seasons, they lost about all of their foliage before frost.

There is no doubt that Elvira, Delaware, and all vines which are usually seriously damaged by mildew here, were greatly benefited by the remedies applied, and their vigorous young growth, matured to the tips, promises a better crop next season than ever before. About the end of October a still harder frost killed the leaves of Elvira and all other vines belonging to the species *V. riparia*, *rupestris*, and *V. Berlandieri.*

Vitis monticola resisted even to this last frost and preserved a perfect foliage to the cold wave of November 10, thus proving itself able to stand a lower degree of temperature than all other species of American grape vines.

CONCLUSIONS.

While last year (1887) owing to a destructive hailstorm in July it was difficult to correctly estimate the respective value of various remedies, everything here proved at least their value as a preventive of mildew.

This season (1888) fully convinced me that with Bordeaux mixture and eau celeste (with or without adding soda), we have mildew under our control in any season and on all kinds of grape vines, provided we apply the remedies early and often enough. *Early enough* means just as soon as the leaves begin to appear. *Often enough* varies with the variety you treat and the season you operate in. Experience and judgment must guide us. I consider it indispensable to make the first application early on all vines and in every season without exception.

A second spraying just before and a third one right after blooming must likewise never be omitted, and if, notwithstanding these treatments, any spots of black rot appear on the foliage, pick off and burn every affected leaf at once, for on these mature most of the spores that produce the black-rot fungus on the fruit.

These first applications are comparatively easy, owing to the small size of the young growth, and they will secure the young branches, leaves, and berries during the most critical stage of their development, Later applications had better be made on all vines at least once per month until the end of August. It is true that on a few of the most resistant varieties (Norton, Perkins, Ives, Rupestris), in many seasons the late treatments may be omitted with comparative safety. Yet with the Vermorel or some other good pump, the labor and cost of a treatment is too small to take any risks.

All vines liable to rot or mildew, or both, must never be sprayed less than once per month after their fruit is well set. During the rapidly growing season twice a month is far better, especially where rain, fog, or heavy dews prevail.

My favorite remedy at the end of last season (1887) was eau celeste. Bordeaux mixture proved equal to it for preventing mildew, but occasionally clogged the nozzle of the pump. Therefore the bulk of my spraying this year was with eau celeste, and Bordeaux mixture was applied to comparatively few vines. This I now consider a mistake, since Bordeaux mixture has given best results against rot; but wherever both rot and mildew must be prevented I shall henceforth use Bordeaux mixture. (See table August 10.)

Where the prevention of mildew is the only object of a treatment I will continue to use eau celeste with the addition of soda. The soda addition leaves plainer marks on the sprayed leaves, and thus enables us to better control the thoroughness of the spraying.

Sulphatine I will not apply to bearing vineyards again. It is a slow and difficult work to thoroughly dust every grape and leaf on a strong growing old vine without getting on too much and thus scalding some portions.

For young vines and plants in nursery rows I like sulphatine well. Also found it excellent to apply against oidium or powdery mildew on roses. In planting young vines here I still think it safer to set only varieties that are comparatively free from black-rot. Some of our most desirable grapes are discarded mainly or only on account of their liability to mildew. Among these are the Delaware and several of the best Riparia Labruscas. All of them we may now safely plant here for profit, provided we will treat them with copper remedies.

With these remedies (especially the Bordeaux mixture) applied early and often we can certainly reduce the ravages of black-rot, and it is quite possible we may yet succeed in preventing it with as much certainty as we thus can prevent mildew.

Meteorological report for 1888.

	Temperature.			Rain.	Dew.	Fog.
	6 a. m.	1 p. m.	6 p. m.			
May 1	32	75	72	.....	Frost; no damage.	
2	50	80	74	.....	Heavy	
3	48	60	56	.....	Light	
4	44	70	65	.....	Medium	
5	47	79	73	.....	do	
6	64	84	76	.....	do	
7	63	83	64	0.1	do	
8	45	58	60	.....	Windy	Misty.
9	47	81	77	.....	Heavy	
10	58	85	78	.....	....	
11	65	75	66	0.1	Light	Do.
12	45	66	58	.....	Heavy	
13	50	74	52	0.1	Light	
14	34	70	50	0.1	Heavy	Light frost.
15	46	78	68	2.2	do	Rains, showers and mists.
16	47	57	56	1	Rain	
17	56	70	71	0.3	do	
18	50	52	51	2.4	do	
19	43	70	68	.....	Heavy	Heavy.
20	60	71	68	.....	do	
21	64	80	66	.....	do	
22	58	80	72	.....	do	
23	76	80	78	.....	do	
24	74	82	76	1	Rain	
25	70	80	78	.....	Heavy	Heavy.
26	72	92	80	.....	do	
27	78	84	80	.....	Light	
28	60	82	78	.....	do	
29	62	85	70	.....	Heavy	
30	70	92	78	.....	do	
31	62	72	76	.....	do	
June 1	70	96	70	.....	do	
2	54	88	68	.....	do	
3	54	77	80	.....	do	
4	62	78	76	.....	Light	
5	70	88	86	.....	Windy	
6	76	92	80	0.1	Mist	Misty.
7	78	88	76	0.2	Heavy	
8	66	60	72	3	do	
9	60	82	70	0.6	do	
10	60	81	68	.....	do	
11	58	82	75	.....	do	
12	62	88	86	.....	do	
13	62	90	86	.....	do	
14	68	90	82	.....	do	
15	72	93	84	.....	do	
16	72	94	88	.....	do	
17	82	94	70	.....	Light	
18	70	84	72	0.5	Rain	Rain.
19	70	82	70	0.2	....	Mist.
20	72	92	72	.....	....	Misty.
21	73	82	80	5.7	Light	
22	68	65	62	1.8	....	
23	62	72	68	.....	Heavy	
24	70	85	76	.....	do	
25	70	88	78	.....	do	
26	76	85	76	1.1	do	
27	72	88	78	.....	do	
28	70	86	80	.....	do	Heavy.
29	72	88	80	.....	do	
30	70	90	82	.....	do	
July 1	78	91	86	.....	Heavy	
2	80	89	85	.....	do	
3	80	90	86	.....	do	
4	76	96	88	.....	do	
5	78	96	89	.....	Light	
6	78	91	86	.....	Heavy	
7	78	90	84	.....	do	
8	76	90	78	0.3	....	Misty.
9	76	83	75	1	Misty	Do.
10	71	80	74	.....	Heavy	Heavy.
11	71	85	78	.....	do	

	Temperature.			Rain.	Dew.	Fog
	6 a. m.	1 p. m.	6 p. m.			
July 12	75	93	85	.....	Heavy	
13	80	94	87	.....	do	
14	80	95	88	.....	do	
15	80	91	86	.....	do	
16	76	92	88	.....	do	
17	75	90	86	.....	Medium	
18	74	89	84	0.1	Mist	
19	76	83	78	.....	Heavy	
20	77	88	76	.....	do	
21	73	86	77	.....	do	
22	70	84	78	.....	Medium	
23	80	92	81	.....	do	
24	80	90	82	.....	do	
25	82	92	88	.....	do	
26	80	94	88	.....	Light	
27	80	93	87	.....	do	
28	82	97	90	.....	do	
29	80	99	92	.....	do	
30	81	99	92	.....	do	
31	80	97	89	.....	do	
Aug. 1	82	99	91	.....	None	
2	81	99	90	.....	do	
3	80	98	88	.....	do	
4	72	94	84	0.7	do	
5	79	92	85	.....	Medium	
6	72	90	83	(*)	Windy	
7	71	80	80	.....	do	
8	73	85	78	0.2	Mist	Do.
9	68	80	76	.....	Light	
10	78	89	79	.....	do	
11	79	92	82	.....	do	
12	80	78	75	0.2	do	
13	75	88	78	.....	Heavy	Do.
14	73	90	82	.....	Light	
15	75	91	83	.....	do	
16	86	96	85	.....	None	
17	84	93	82	0.1	Light	
18	76	89	78	.....	None	
19	76	88	79	.....	do	
20	75	85	76	(*)	do	
21	72	79	75	.....	Heavy	Light.
22	68	77	74	.....	do	Do.
23	67	75	70	.....	Light	
24	63	82	76	.....	do	
25	70	86	78	.....	do	
26	70	84	72	0.8	Cloudy	
27	72	85	70	0.1	do	
28	70	83	69	0.1	do	
29	70	82	72	0.1	Heavy	
30	69	74	72	0.6	Rain	
31	79	80	76	.....	Heavy	
Sept. 1	58	75	73	.....	do	Trace
2	58	77	74	.....	do	
3	56	78	76	.....	do	
4	60	80	77	.....	do	
5	61	80	76	.....	do	
6	63	82	77	.....	do	
7	68	88	79	.....	do	
8	70	89	80	.....	do	
9	76	89	80	.....	do	
10	70	90	80	.....	do	
11	68	89	82	.....	Medium	
12	67	82	78	.....	do	
13	69	87	75	.....	do	
14	70	88	76	0.3	Misty	
15	66	78	70	.....	....	Heavy.
16	64	75	66	.....	Windy	
17	49	78	70	.....	Light	
18	56	83	73	.....	do	
19	57	82	75	.....	do	
20	62	84	76	.....	None	
21	60	86	79	.....	Light	
22	62	88	82	.....	do	

*Sprinkle.

Respectfully,

HERMANN JAEGER, *Special Agent.*

HON. J. M. RUSK, *Secretary of Agriculture.*

REPORT OF A. M. HOWELL ON THE DISEASES OF THE VINE IN SOUTH CAROLINA.

DOWNY MILDEW.

Peronospora viticola, DBy.

What is known as the downy mildew of the vine (*Peronospora viticola*), which causes "brown-rot," has been known to this State from time immemorial. Its true nature, and even the fact that it is a fungus or parasitic plant, bearing spores (seeds), by means of which it spreads and reproduces itself like plants of higher orders, was not generally known until within comparatively recent years. Over thirty years ago Mr. J. N. Jones, of Charleston, wrote of it in the Gardeners' Monthly as follows:

> I have always considered mildew as a disease of plants, or at least as a cause of disease, regarding it as a parasitic fungus, feeding upon the sap, obstructing the respiration, and destroying the vegetable tissue. I observed, however, that before the fungus made its appearance, and before any trace of it could be discerned under a high magnifying power, the leaves put on a peculiar glazed appearance, evidently caused by the exudation of some gummy or viscid matter oozing out of the stomata, gradually spreading over the surface, and drying in the form of a thin pellucid pellicle scarcely distinguishable by the naked eye. Upon or under the pellicle, after some days, the vegetation of the fungus was distinctly observable in the form of fine threads, ramifying in all directions exactly as a mushroom spawn runs through a brick. * * * Fine particles of dust adhere so thickly on the viscid surface as to interfere with a good view of the object. In a few hours, under favorable conditions, little globular bodies may be observed forming all over the net-work of fibers. These burst through the thin layer of extravasted sap, "coming up" very much like a fine crop of mushrooms. On twirling an affected leaf in a tumbler of warm water the gummy matter dissolved, and carried in it the fungi, root and branch.

From the last observation, Mr. Jones concluded that mildew was not a parasite in the proper sense, but rather a scavenger, arguing in support of this view that mildew does not exist and can not exist upon a healthy vegetable surface. He maintained that the viscid excrement thrown off by the leaves underwent decomposition, and that wherever decomposition was going on there mildew would be found in one form or another, the pores remaining closed by reason of the viscid film covering the leaf, preventing or injuriously retarding respiration, under which circumstance it was impossible for the vine and its fruit to keep up a healthy growth. The effect was that of suffocation. "The application of lime," concludes the writer, "or sulphur, may cause the destruction of the fungus by acting upon and purifying the viscid sap. Possibly, however, the plentiful use of warm or even hot water, where it can be used, might be quite as efficacious."

The foregoing quotation is intended to show the stages through which our knowledge of the nature of the fungus and the means of preventing its ravages has passed. At the present time the whole matter is more thoroughly understood. It is now known that Mr. Jones was mistaken when he thought that by washing an affected leaf the entire fungus was taken from it. Closer scrutiny would have revealed to him the mycelial threads which had penetrated between the tissues of the leaf. And a more studious observation of the direful effects of the fungus on the fruit would have convinced him that the fungus was considerably more than a scavenger. His arguments on the absence of mildew on a healthy vine are sufficiently strong, however, to deserve discussion. This will be considered when we inquire into the physiological conditions under which mildew and rot do not occur.

The percentage of loss to vineyardists of this State from this form of rot has never been very great in any one year, but it must be noted that it is only in the upper tier of counties adjacent to the Blue Ridge Chain that grape culture is engaged in to any considerable extent. There are some small vineyards in the middle and lower conutry. The Scuppernong is grown to some extent throughout the State, particularly in the flat swampy lands of the southern counties, where it and its kindred varieties, the Flowers, the Thomas, and the Tenderpulp, are the only grapes that succeed. In this report of the fungous diseases of the vine and the success attained in combating them, it will be understood that all allusions will be to the more tender cultivated varieties of the Labrusca, Æstivalis, and Riparia species and the Vinifera hybrids, and not to the members of the Vulpina or the Muscadine family from which the Scuppernong comes. I know of no fungus that attacks the Scuppernong in this locality. In the swampy lands of the low country, where there is great humidity compared with the rolling land of the hill and mountain regions, success with the finer varieties of grapes has always been extremely precarious, owing to mildew. Generally the first baleful effect of the action of the fungus was an almost complete defoliation of the vine. If this was not accompanied with wholesale rot the result was just as bad, since it was impossible for the fruit to ripen without the help of the leaves. Hence it has followed that all efforts at grape culture in these humid sections have been abandoned, except with the inexpensive garden arbor, which with good management, in dry years, will yield a reasonable quantity of palatable fruit for domestic use. In the drier sections of the mountainous part of the State, and in the middle country, the history of grape culture dates from about the year 1873. In this section the crops of the first ten or twelve years were fine and abundant. On the immediate salt-water coast grape culture has never assumed large proportions, but within the past few years enterprising farmers and market gardeners have engaged in the business, and, with some exceptions, have met with a fair share of success. It is claimed by some of the coast country people that the effect of the salt atmosphere, blowing directly off the sea, prevents fungous growths. As grape culture is yet in its beginning in that section, this can not be accepted as a positive fact, since it is shown that young vines are comparatively exempt from fungous attacks in the sections higher up, where the fruit of the older vines of the same varieties rots disastrously.

Some time before the late civil war, in the vicinity of the city of Columbia, a vineyard of several acres of Lenoir and Herbemont grapes, the former being a native of South Carolina and the latter of Georgia, was planted and for some years successfully cultivated. It was finally abandoned, however, whether because of rot or other discouragements I have not been able to learn. With this and a few other like exceptions in other parts of the State no well-planned and systematic effort in viticulture had been made until the vineyards of the Piedmont belt loomed into notice on account of their enormous crops of spotless and perfect fruit. The first vineyards were planted in the counties of Greenville, Oconee, Chester, Abbeville, and Richland. During the first ten years of the life of these vineyards, as previously stated (until the year 1885), regular annual crops were produced without rot of any sort. There were sporadic attacks of mildew during rainy seasons, but the loss was so slight as not to attract general attention or to excite alarm.

BLACK-ROT.

Læstadia Bidwellii (V. & R.).

Black-rot began its ravages in 1885, and the loss to the vineyardist from this cause has increased every year. This year the destruction of the crop was practically complete in many vineyards, only first and second year vines maturing a profitable crop, and generally with these the loss was sufficient to be felt, except in one instance which I shall mention further on, and which brings to view for the first time here a system of pruning and management worthy of close study and trial. Whether black-rot ever made its appearance here previous to 1885, is a question I am not able to answer, for the reason that I have not found an individual of the old school who had learned anything of fungous diseases or could tell whether there was more than one kind of rot. It is possible that the pest which now amounts to a scourge has been here before, though circumstances indicate that this was its first appearance (1885). At first grape growers manifested a disposition to conceal their alarm, and seemed desirous of hiding the fact of the presence of the disease, which none understood, in the hope that it would pass away as it came, and no discouragement to the new and then "blooming" industry would result. The first and second years of the black-rot resulted only in a small percentage of loss; in 1885 about 10 per cent. in infested vineyards, and in 1886 probably 25 per cent. In the latter year the disease spread into vineyards that showed no signs of infection the previous year, and, with one or two exceptions, rot became general in 1887. In that year the loss in the vineyards that became diseased in 1885 was from 50 to 75 per cent. of the crop, while in those in which the *Læstadia* made its appearance in 1886 the loss was only from 5 to 10 per cent. In the same way in vineyards that had no rot in 1887, or in those which bore their first crops in 1888, the loss was this year only from 5 to 10 per cent. This year, 1888, every vineyard, so far as I can learn, except in some instances where the vines were bearing their first crops, has been affected with black-rot. In some of them the loss amounted to almost the entire crop. These facts seem to show that the fungus spreads or increases more slowly than some would suppose, since it takes three years of unchecked progress to gain complete possession of a vineyard, counting from the time of the first infection. I say unchecked progress, for nothing has been done to check the progress of the fungus from the time of its first appearance to the present, except in the instance above alluded to, which will be explained before I conclude. At first our growers, native and foreign, knew nothing of the trouble. They could not tell the difference between black-rot and brown-rot, and when a third enemy appeared in the field in the shape of anthracnose (*Sphaceloma ampelinum*) they reckoned that "their goose was cooked." Some enterprising vineyardists were undismayed, however, and with commendable energy engaged in an unequal fight, in which the three species of fungi had all the advantage. Others, with younger vineyards, not yet having suffered a severe loss, clung to the hope that theirs was a more favorable location and soil, and that their grapes would not rot so badly as their neighbors', and did nothing. In this they saved their pains, however, for no good results followed the application of mixtures by those who tried them. The mixtures used were generally nearly or quite the same as that known as the copper mixture of Gironde, or Bordeaux mixture, which was suggested for trial by the Department of Agriculture. Others tried the ruinous process of defoliating the vine "to let the air and light in."

Theories as to the cause of the rot and the proper remedy to be resorted to were very abundant, and some of them, wholly at variance with the discoveries of science, coming from men of prominence and influence, intensified the prevailing confusion. I heard of one or two instances where the roots of the vine were laid bare and some of them cut to prevent a surcharge of sap in the vine. Some beginners refused to accept the fungus or spore "theory," and believed that the disease was inherent in the vine and would always result in seasons of continued rainy weather, whether the fungus was in the vineyard or not. If the fungus was always present on rotting grapes it was the result of the rot and not the cause of it. Such was the state of the question while the ruin continued, and the grapes rotted at a fearful rate. Mr. S. C. Satterthwaite, of Aiken, S. C., Mr. G. Wanner, of Walhalla, and Mr. H. B. Buist, of Greenville, were among those who had faith in sulphate of copper and lime, and they applied these with painstaking care, but without the desired results. I have not heard of an instance where the application of a compound of any sort has prevented or checked the ravages of either *Læstadia*, *Peronospora*, or *Sphaceloma*, except with Mr. Buist, whose vines did not drop their leaves where treated, as others did when attacked by mildew. In every case that I know of a good reason can be shown why the applications were not effectual, and it is this: they were made too late in the season, after the vines were teeming with rot and every part of the vineyard affected with fully developed spore-bearing fungi. Whether the remedies or preventives applied in these instances would have been effectual or not had they been applied earlier none can say with certainty, but it seems to be certain that nothing can prevent the destructive action of the fungi after the mycelium or vegetative part of the same has penetrated through the skin and into the pulp of the berry. The fungus is then beyond the reach of a remedy that would not destroy the fruit and greatly injure or kill the growing parts of the vine. The question of earliness in the application of preventives is a matter of the greatest importance in our southern latitudes.

It must be remembered that the growing season here, and with it the temperature and conditions sufficient to bring fungi into activity, is far in advance of that of the Northern States. We read in the reports of the application of the copper solutions at the North late in May and June, before the fungus has made its appearance in that section, while at that time in the South the fungus has already developed, and the grapes are already rotting on the vines. The fungi of the vine do not consult the almanac to find out the seasons. It is heat, accompanied with the necessary moisture, that brings them into active life, and, unfortunately for the grape-growers, the rains of April and May are sure to come. It is true that our spring time is variable, and it is always a question with the farmer and fruit-grower whether we will have an early spring or a late one, as much depends upon it in the planting of all our crops. Black-rot generally attacks the fruit when the berries are about one-third to one-half grown, and they reach that growth here ordinarily by the 15th or 20th of May. This year (1888) I found in my own vineyard, on May 25, berries that were fully half rotten. Now, if it takes the spores from eight to twelve days to reproduce the fungus it is plain that an application designed to prevent the germination of those that have survived the winter ought to be made at least two weeks before the time for the first manifestation of the disease. When the matter is properly understood, viticulturists who have failed in their efforts to combat the fungus will see clearly that it is futile to begin the fight upon the parasite after the mischief has been done.

To do the work intelligently, to give a remedy a fair trial, requires a rudimentary knowledge of the nature of the habits of the fungus, which can be acquired by a careful reading of the Department reports, and by close observation, even without the aid of the microscope. The intelligent grape-grower ought to be sufficiently acquainted with the different parasites to hold them before the mind's eye at all times, and to know the conditions under which they are active and destructive to his crop. I am glad to say that I believe such a knowledge of the pests of the vineyard will soon become general, or sufficiently so as to insure intelligent, systematic, and uniform work.

During the past season the black-rot fungus seriously attacked growing shoots of the vine in some of the vineyards in this section. In my own vineyard I notice at this time (November 20) that the tips of many of the canes are dead, and I have no doubt that the general health of the vine is greatly impaired. So far as I can learn by correspondence with grape-growers of different counties in the State, the effect of black-rot is very nearly the same, regardless of soil and location. Mr. S. C. Satterthwaite, of Aiken, one of the leading fruit-growers of the State, writes as follows under date of November 13, 1888:

> I have tried almost everything recommended by various authorities, and have met with disastrous failure. Last year what promised to be a $5,000 crop was reduced by this terrible scourge to less than $500, and the present season the destruction was even greater. A party in Ohio advised sowing sulphate of iron broadcast among the vines. I did so at the rate of 3,100 pounds to the acre upon 5 acres, and in addition to this upon a portion of the vineyard I had the vines well covered with air-slacked shell lime. All this was done before the grapes were in bloom. I also used upon the other portions of my vineyard the copper solution, copper and sulphur and ammonia water, also diluted carbolic acid applied to the fruit. Seeing that some one reported exemption from the rot by sowing oats in the vineyard, I also tried that plan. I also tried the renewal plan of cutting the vines off at the ground in the spring and having them produce new wood throughout for the next seasons' fruiting. I also *left occasional rows untreated* and could not discover but that they fared as well as any. Nothing was apparently of the least benefit. I have bagged grapes with partial success. Were it wholly so one great objection is that it renders the fruit more tender and unfit for distant shipments. * * * We have two well defined periods of attack. This season the rot commenced May 18 and continued for about one week; then it commenced again June 20 and spread rapidly until July 1, but did not stop entirely until there was no more fruit for it to feed upon. I find the Concord one of the varieties least affected by the black-rot, while Niagara, Empire State, Duchess, Triumph, and Jessica are among the greatest sufferers. * * * My grapes rot just as badly in high, dry, sandy soil as upon loam with stiff clay subsoil. I believe the slight protection afforded by stretching strips of cotton cloth over the rows would render them free from rot if means could be devised for holding them in place during high winds. Vines trained against my packing-house produced sound fruit, while in the vineyard adjacent there was not a sound cluster, and upon many of the vines not a sound berry.

Mr. G. Wanner, of Walhalla, a German grape-grower of large experience, writes:

> My treatment of the vine with Bordeaux mixture has not been crowned with the expected success, and I was compelled to take recourse to my never-failing preventive of picking the diseased berries daily, and thereby checking the spread of the disease. However, I will not say that sulphate of copper solution does not demonstrate that by proper application of the compound the most terrible scourge of the vineyard may be successfully combatted, as experiments by other grape-growers have convinced me. The system of management of our vineyards, especially the pruning, is a great factor in keeping the fungi from them, as Mr. Jaffeux's management clearly shows. * * * The renewal system, or what you call the Jaffeux system, I have followed since I began the culture of the grape.

In the vineyards of Greenville County, aggregating about 400 acres, most of them being not over 5 or 10 acres, there is only one, so far as I can learn upon inquiry, that was free from rot this year. It is that above alluded to as being pruned and managed differently from any of the others, the system pursued having been adopted by the proprietor, Mr. Paul Jaffeux, as a means of preventing rot. Mr. Jaffeux is a native of France, in which country he spent his earlier life in viticultural pursuits. He has been in this country about fifteen years, and has devoted his time to the production of grapes which he makes into wine. In his system of pruning and management he has several objects in view: First, to prevent rot and promote health and vigor in the vine; second, to limit the product of each vine to twenty-five or thirty bunches of grapes, thereby to insure better development and quality of fruit; and third, the production of fruit near the ground where the temperature is higher and which it is claimed develops a greater percentage of sugar in the grapes.

His vineyard is about ten years old and has borne five crops of excellent fruit, the berries being larger than the same varieties in other vineyards near by, and doubtless sweeter, though a comparative test has not been made with the saccharometer. The location is upon a gentle northward slope of a sandy loam soil, which is underlaid first by a stratum of mulatto clay and under this by a clay of deeper color, containing much oxide of iron. The vines were planted in trenches instead of in square holes as in the neighboring vineyards. The trenches serve to drain the soil and thereby, in wet weather, to abate humidity in a short time after the cessation of the rain. The vines are set closer than in most vineyards, the distance apart being 6 by 6 feet. They are trained to perpendicular stakes as they grow in summer; one, two, and sometimes three stakes to the vine. From the time of planting until the vines were five years old they were cut to the ground every year, and at that age they were allowed to bear a light crop of fruit. Each year in the month of February every vine in the vineyard is practically cut off at the ground, and the appearance of the vineyard after pruning is as if no fruit was expected that year. Two, three, or four upright spurs of last year's growth are left upon each root, however, and these, numbering from eight to ten bearing eyes, produce the desired number of bunches, twenty-five to thirty. That such pruning and such a limitation of the quantity of fruit to each vine promotes vigor and healthfulness there can scarcely be a doubt. It is proven by the diameter of the canes, which are twice as large as those in the ordinary vineyard.

That fruit of very superior quality is produced is proved by the fact that the berries are much larger than the same varieties in other vineyards which are pruned differently. That it is wise to limit or curtail the quantity of fruit each year is proved by the steady and invariable regularity with which his vines produce the given quantity. But the most important point gained, as is claimed with a good show of argument, and which I believe will stand the test of scientific investigation, is the eradication of fungi, even if the vineyard should catch a fungous disease every year. Let it be explained here that the vineyard is kept scrupulously clean and that every part and parcel of the prunings are removed and burned as soon as the pruning is finished. The vineyard is kept in clean condition all summer by frequent hoeings. The vines are carefully summer-pruned, the laterals opposite each bunch of fruit, and even those at these joints above the topmost bunch are carefully removed. By this means the vineyard becomes a new one from the ground up every year. The spores that may have lodged upon the vine during the summer are carried out in the pruning and gleanings as above described. Other vineyards in the same locality, one in sight and another nearly so, showed a mass of rotten fruit this year and last, the loss in the nearer one being complete and in the other one hardly less than 75 per cent. while that of Mr. Jaffeux stood in strong contrast. with no rot, healthy foliage, and large bunches of fine berries, which had suffered no damage except from a hail-storm while the fruit was green, and from this most of the berries recovered.

There are others, however, who claim to have practiced the same renewal system for years without effect in preventing fungous attacks, but an examination will show that they have left some vines or other source of disease in the vineyard.

In his letter already quoted Mr. Satterthwaite says: "I also tried the renewal system, *i. e.*, cutting the vines off at the ground in the spring and have them produce new wood throughout for the next season's fruiting. I also *left occasional rows untreated*, and could not discover but what they fared as well as any."

A moment's reflection will show that the untreated rows, from which numbers of spores were floating with every breath of air, immediately communicated the disease to the fresh new vines produced by the renewal plan Mr. Satterthwaite had tried.

From the same reasoning it is clear that yearly re-infection would take place in cases where two or more vineyards are located near each other or which are in line with the prevailing direction of the wind, unless both or all of them are treated in the same manner. Hence the importance of uniform concert of action between neighboring vineyardists.

Mr. Wanner, of Walhalla, pursues what is known with many vinegrowers as the renewal system of pruning, and, technically, it is probably correctly named. While Mr. Wanner's vines are nearing a crop of fruit he trains up others from the root or "head" at the ground to take their places. Hence, in the growing season he has two sets of vines, one in bearing and the other intended for the next year's fruiting. In the fall or spring he cuts away the entire vine that has borne a crop the preceding season and replaces it with the new vine. It will now be seen that the young vine, growing immediately beside the old one which bears rotten grapes, is exposed to the attacks of the fungus the entire season. The transition from Mr. Wanner's system to that of Mr. Jaffeux is only very slight, but it amounts to a great practical difference.

In relating these experiences and observations I have ignored the question of the efficacy of the Bordeaux mixture and other fungicides, because other beneficial results which contribute in a great measure to the prevention of rot follow wise management, besides the removal of the spores of the fungus from the vineyard. One of the chief merits of the cutting-back system pursued by Mr. Jaffeux is the production of very stout and vigorous-bearing canes which, it is generally conceded, have a greater power of resistance to the attacks of fungi than small, weak, debilitated ones. Another important consideration, and one that every grape-grower should bear in mind, is that of limiting the quantity of fruit each vine shall bear to the capacity of the vine. If all the vital forces of the vine are expended in the production of fruit, the vine will soon fail. When it has become weakened and exhausted from overbearing it is an easy prey to its parasitic enemies. The intelligent and progressive viticulturist will not depend upon fungicides alone as a means of producing a fine crop of fruit.

In the consideration of this branch of the subject we raise questions of prime importance, which have much to do with our success in the production of sound fruit. In the matter of the proper planting of the vine alone, and in that of drainage, I am sure we are much at fault. Most of the vines in this section were planted in holes 3 feet in diameter and 18 inches deep, dug into stiff clay soils. In many instances the walls of these holes, the soil being a tight waxy clay, are impregnable to the roots of the vine. In addition to this disadvantage these holes fill with water during the seasons of rain in which the fungus attacks occur, and the principal means of escape for this water is by evaporation. Thus the vines stand literally in tubs of water, the soil being too impervious to admit of anything but very slow leaching. In addition to the fact that the actual presence of water upon the vine may be necessary to the germination of the spores of *Læstadia* and *Peronospora*, I am confident that this excess of moisture in the soil and the continual evaporation therefrom keeps up a degree of humidity in the vineyard sufficient to promote the growth of fungi for some days after the rain has ceased. If the same soil were well drained and the vines planted in trenches running slightly down hill the humidity spoken of would end in a few hours after the rain had ceased. The mere germination of a spore of black-rot does not produce rot. It must send its mycelial threads through the skin of the berry before it can become independent of external moisture. I have many times observed that, with a sudden change to clear dry weather, the growth of the fungus was arrested and brought to a complete stop, when the merest speck, not more than the twentieth part of an inch in diameter, was to be seen. I have watched these spots and found that they did not enlarge but remained *in statu quo* until the grapes were harvested and shipped, or consumed. On the other hand, I have repeatedly noticed, in instances when the rain had ceased but the weather remained cloudy or partly so, though the vines were not wet, that the spots on newly-attacked berries increased in size until the whole berry rotted. I have observed the same thing with anthracnose, and during the past season, *Peronospora* noticeably did most of its work a week or more after the rains had ceased. In the latter case no new infection took place, but where the fungus had taken good hold upon a vine the brown rot continued for several days after black-rot and anthracnose had become inactive. From these facts I am convinced that thorough drainage, by which the vineyard will be dried out in the shortest possible time after rains, will be the means of promoting healthy root growth, and in many cases of saving a considerable portion of the crop of fruit. The next consideration looking to the promotion of the health of the vine is that of feeding it upon a sufficiency of wholesome food. In this particular I am forced to believe that most of our vineyards are sadly neglected. An idea prevails with some growers that the grape-vine needs no manuring, that it finds all it wants through the feeding roots which permeate the soil. Such unreasonable notions do not obtain, of course, with those of riper experience, but even these are negligent, because they do not see or feel the importance of the matter. Not unlikely stable and other humic manures that undergo fermentation in the soil are not the best fertilizers for the vineyard. But that the vine should be supplied abundantly with mineral fertilizers, no one will deny after a moment's reflection. It is well known that both the wood and fruit of the vine contain a large percentage of potash, phosphoric acid, phosphate of lime, and lime. Chemical analysis shows in the ashes of the wild grape-vine 21 per cent. of potash, 15 per cent. of phosphates, 17 per cent. of lime, 4½ per cent. of magnesia, 2 per cent. of soda. Analyses made in France of the ashes of the vines of Burgundy and other districts show, potash 45 per cent., lime 35 per cent., phosphoric acid 7 per cent., magnesia 5 per cent., soda 4 per cent., with small quantities of sulphuric acid, chlorine, and other substances. The analysis of the fruit of the vine shows even larger percentages of these elements except simple lime.

Farmers know that phosphoric acid, potash, and often lime are among the elements in which most soils are deficient, and that these, with nitrogen, are the requisites of a good fertilizer for cotton or corn. No farmer will attempt to raise either of these crops continuously without an annual application of a fertilizer containing these ingredients in good proportions. When we remove from the vineyard several tons of grapes per acre yearly, besides large quantities of the wood of the vine in pruning, how can we fail to see that the soil is being rapidly exhausted of the food that is absolutely necessary to the life and health of the vine?

This view of the healthful effects of liberal manuring with potash, lime, and bone seems to be sustained by the remarkable fact that young vines with their first crop rarely ever rot to any injurious extent, if at all. The assumption is that vines in their youthful state of vigor, having parted with none of their vitality in the production of fruit, and growing in a soil that has not previously been heavily drawn upon, have the power to resist the attacks of the fungi.* In my own vineyard during the past season I saw this power amply illustrated. I had several young vines which occupied the places of cuttings that had failed to take root at the first planting, and which were not replanted until two years later. They were in new soil, therefore, but surrounded on all sides by vines on which the loss from black-rot was fully 90 per cent. The fruit of these vines, this being their first crop, was only slightly affected, the loss being not more than 5 per cent. I know of like instances in other vineyards, and of entire vineyards of from 6 to 8 acres, namely, those of Mr. James C. Anderson, of Spartanburgh, and Mr. Waite, of Anderson County, in which this year's crops, being the first, were wholly exempt from rot.

The history of the vine in this State, as collected from growers of several of the viticultural counties, has been that after five or six regular crops the vines became slothful and unprofitable, contracting mildew to a greater or less extent, and ceasing to produce grapes of good quality. That this decline has been due to a want of nourishing food of the nature indicated above, and to a want of intelligent pruning and management, is, in my opinion, proved by the better results which have followed a reasonable compliance with the requirements of the vine in recent years.

Mineral fertilizers, unless accompanied with nitrogenous manures, as stable manure, do not produce excessive vegetation, while the latter does. The former tends to the production of hard, firm, and healthy wood, while the latter has the opposite effect, causing rank and more spongy growth, in which, for obvious reasons, the fungi have a more favorable environment.

It is not claimed that simple sanitary precautions and the proper nourishment of the vine will render it fungus-proof, but that they are aids in the right direction.

In conclusion I would say that experience in this section of the country forbids the hope that varieties may be found that possess the inherent power to resist the attacks of the fungus. Even the thick-skinned, acrid Ives has this year succumbed to the black-rot, where it was formerly believed to be thoroughly resistant. As a rule the choicest varieties are most subject to the maladies and those only are profitable for marketing. If there are instances in which any variety of grapes, out of the great number grown here, has not been affected by some form of rot I am confident that an explanation can be found other than that it is a resistant variety. Any variety will yield to fungous attacks under adverse circumstances.

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* On the other hand it is also true that we often find black-rot flourishing on the most vigorous and best cultivated grapes. There is no absolute proof that the fungus requires weakened vitality in order to attack a plant.—Ed.

Anthracnose made its appearance in this section in 1886 and was very devastating upon certain varieties in the vicinity of Walhalla. Some vineyards near Greenville became affected with it in the same year. This fungus seems to have an especial fondness for the Elvira grape and seems to affect other white or light-colored varieties more than the black, except that it is common on the Clinton. Its ravages are not confined to any particular varieties, however, as it was noticeable on eight or ten different varieties here during the past season, including the Concord and Ives. I noticed as many as eight distinct infections on one Concord berry in the vineyard of Mr. James McPherson, of Greenville. The attacks of anthracnose seem to come later than black-rot; at least it was the case this year. Black-rot raged for about ten days before anthracnose became noticeable, and soon after its appearance the rains held up and left it without the necessary moisture to accelerate its progress in those vineyards in which the black-rot had left any fruit for it to attack. The loss resulting from anthracnose was therefore very light. As this disease seems to operate near the surface of the berry, the stoppage of its ravages before the spot produced has grown large leaves the berry in such a condition as will not prevent ripening, and the grapes thus only slightly affected may be used in making wine. Whether the presence of the fungus in the fermenting-vat will have any injurious effects on the wine I do not know. Anthracnose has had but little history in this section, but it is believed that whatever treatment will exterminate black-rot will also end the existence of anthracnose.

Respectfully,

A. M. HOWELL.

Hon. J. M. RUSK,
Secretary of Agriculture.

SUPPLEMENTARY REPORT.

Since forwarding my regular report I have received a number of delayed replies to my letters of inquiry to vineyardists in the State, none of which, except that given below, furnish any additional information as to the prevention of grape-rot in this section of the country. The following is in reply to a note addresssd by me to Mr. J. J. Stringfellow, of Chester, S. C., one of the largest grape-growers and wine-makers in the State. The report is made by Mr. Louis Jourdan, manager at Cote Rouge, the name of the vineyard, and is as follows:

> The 1st of last May I noticed some traces of mildew and yellow spots on the leaves of a plat of Ives vines. Having tried a solution of bluestone on it the year previous with some effect, I resolved to commence this year (1888) three weeks sooner.

> I dissolved 1 pound of sulphate of copper in 20 gallons of water, and sprinkled the vines with the solution before the blooming season was over, and waited a few days to see the result. On going over the vines I became disgusted with my work. The leaves of the vines were badly scorched, and I thought I had ruined my crop, but three weeks later the aspect of the vines had undergone a great change. A new growth had started luxuriantly, and I then observed that the leaves affected were the only ones scorched and perforated. Of course I did not believe this treatment would save the grapes from black-rot, but in June, in going over the vineyard, I was surprised to find the plat treated almost free of disease, while the rest of the vineyard was badly affected. It continued so until the ripening season, and from the two hundred vines treated I could not have gathered 10 pounds of rotten grapes, while from a plat of the same variety not treated I did not have the fourth of a crop.
>
> The experiment proves this: The copper solution must be applied very early in the season, but in a weak state, and repeated with increasing strength, when the leaves have acquired some toughness, two or three times during the season.

Mr. Jourdan also recommends that the vines and stakes of the vineyard be washed with a strong solution of sulphate of iron and lime in February, before vegetation begins. To the mixture he would add a small quantity of glue to make it adhere to the stakes and older parts of the vine.

Mr. Jourdan's success confirms and proves the correctness of what I have urged in the foregoing report, viz, the importance of applying fungicides or preventives *very early*. I do not believe that an application before the flowers are open would be any too early, provided the solution be not made too strong. It will be remembered that the embryo fruit of the vine is covered by a cap which protects it until it is formed. For this reason I would prefer to apply the mixture before rather than after flowering, as the sulphate of copper would probably seriously corrode the berries when they are very young and tender. In this connection it should be borne in mind, also, that fungous growths begin very soon after the vegetation of the vine has commenced. Hence the importance of being *on time* with the preventive liquid, to intervene between the first leaves of the vine and the first floating spores of the fungus.

Mr. Moses L. Dorrill, of Georgetown, S. C., whose vineyard lies near the salt-water coast, reports that during the past four years, which is the extent of his experience in grape culture, no rot of any kind has affected his vines. He is not prepared to say, however, that it is the influence of the salt atmosphere that prevents rot. In the same locality rye and oats are badly affected with rust, and wheat can not be grown successfully on this account. These facts tend to disprove the idea that the sea-breezes are preventive of fungous diseases.

The experience of viticulturists in this State leads to the following conclusions:

(1) The vineyard must be well drained by ditches, tiles, or other underdrains, to promote healthy growth of root and vine and decrease atmospheric humidity.

(2) The vine must be amply nourished with the elements (indicated in the foregoing report) which constitute the natural food of vine and fruit.

(3) Close, systematic, measured pruning must be practiced to promote vigor and prevent overbearing.

(4) Fungicides must be applied either before or immediately after the growth of the vine begins in spring, and repeated three or four times during the growing season.

(5) That sulphate of copper, in solution, is the most effective remedy or preventive yet found for combating black and brown-rot.

Respectfully,

A. M. HOWELL.

HON. J. M. RUSK,
Secretary of Agriculture.

RESULTS OF EXPERIMENTS IN THE TREATMENT OF BLACK-ROT MADE AT AIGUILLON, FRANCE, IN 1888, BY M. PRILLIEUX.*

In the course of the researches which I made during the past year concerning the black-rot in the Valley of Garonne, I found at Aiguillon a small center very strongly infected by this disease, in a vineyard belonging to a municipal counsellor of that town, M. Despeyroux, who offered me the privilege of making all the experiments I might deem necessary in attempting to combat this malady, which had shown itself on his vines for at least two years past, and had increased in a remarkable manner during the preceding year. * * *

During the past year (1887), while the grapes which were dried and blackened by the rot still hung upon the vines, I made a careful survey, and systematically noted in a written plan all the plants which were badly diseased. The center of infection was in this way exactly determined.

The part of the vineyard that was treated comprised eleven rows of fifty vines each. The plants badly affected by black-rot in 1887 were distributed as follows (the two first rows, which bore the numbers 1 and 2 on the plan, were omitted from the experiment, which includes the rows from 3 to 13):

Number of row.	Number of plants badly affected.	Number of plants very badly affected.	Total number.
Third	14	3	17
Fourth	9	19	28
Fifth	4	10	14
Sixth	2	9	11
Seventh	5	26	31
Eighth	1	6	7
Ninth	23	4	27
Tenth	....	50	50
Eleventh	26	7	33
Twelfth	17	7	24
Thirteenth	29	....	29

The difference could not be very clearly marked between the plants designated as "badly" and "very badly" affected, and it is to the total number that attention should be given.

The three rows 6, 7, and 8 contained 11, 31, and 7 diseased plants. That is an average of 16.33 diseased plants per row. The three following rows, 9, 10, and 11, contained 27, 50, 33 diseased plants, an average per row of 36.66 diseased plants.

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* From Bulletin de l'Agriculture.

I selected the sixth, seventh, and eighth rows for checks, with a view to a special comparison with the three following rows, ninth, tenth, and eleventh, which I decided to treat with the Bordeaux mixture, thus reserving for the trial treatment the rows which were worst diseased in 1887.

The three rows, 9, 10, 11, were then treated with the Bordeaux mixture of different compositions. That used for the first (ninth row) was composed of 7 parts sulphate of copper and 15 of lime to 100 parts of water; that for the second (tenth row) of 6 parts sulphate of copper and 6 of lime; and, finally, that for the third (eleventh row) of 3 parts of sulphate of copper and 2 of lime.

The first two treatments were made in these proportions, the first May 22, the second June 22, but later I was obliged, in order to simplify the work for want of time, to give the last two treatments, which were made on the 2d and 19th of July, in the uniform proportions of 6 parts of sulphate of copper and 6 parts of lime to 100 parts of water for the three rows.

On the other side of the three rows reserved as checks (sixth, seventh, and eighth) were three rows (third, fourth, and fifth) which, in 1887, had, respectively, 17, 28, and 44 vines seriously affected by the black-rot. I had the first two of these treated with eau celeste, and the third with a simple solution of sulphate of copper according to the process specially recommended in Burgogne.

The third row received four treatments of eau celeste in the proportions of one-half part sulphate to 100 of water; the first was made May 22, the second June 23, the third July 3, and the fourth July 20.

For the fourth row the treatments were made on the same dates, but the first two were in the proportion of only one-third part of copper to 100 of water, with a view of trying to avoid the burns often made on the young leaves by eau celeste. These were in consequence less deep than in the preceding row, but were still quite serious even after the first treatment. The last two treatments were the same as for the preceding row, in the proportion of one-half part of copper to 100 of water.

The fifth row was treated on the same days as the two preceding, with a solution of sulphate of copper at 2 parts to 1,000 of water for the first two treatments and 3 parts to 1,000 for the last two.

The last two rows (twelfth and thirteenth) were reserved for making experiments with powders. But these were made under more unfavorable conditions. On account of delay in sending the material, the first treatment of the twelfth row was not made until June 1, and of the thirteenth row until June 2, instead of May 22, as in case of the others.

The twelfth row, which the preceding year had twenty-four diseased plants unequally distributed (twenty-two in the first half and only two in the second), was treated in halves by two different methods. Cupric steatite was spread over the vines of the first half (from one to twenty-five) and the Carrére powder upon those of the second half (from twenty-six to fifty). The first two treatments were given June 1, and then, in order to simplify matters, and since the results of these first applications were neither satisfactory or interesting, the third and fourth treatments were made like those of the neighboring rows, with Bordeaux mixture, containing 6 parts of sulphate of copper and the same of lime to 100 of water. Since in the half row treated by the Carrére powder there were many vacant places caused by pulling up destroyed vines, ten plants selected in the ninth row outside of the experimental area were treated in the same manner and upon the same days in order to replace them.

Finally, on the thirteenth row, in which there were in 1887 twenty nine plants attacked by black-rot, a considerable number of which had been torn up, a powder composed of one-tenth of pulverized sulphate of copper and nine-tenths of triturated sulphur, was employed for the first and second treatments, made June 2. The last two treatments were made July 2 and 19 with Bordeaux mixture in the proportion of 6 parts sulphate of copper to 100 of water.

At the end of May a few spots which could be attributed to black-rot began to show themselves upon the leaves, but it was not until June 8 that conceptacles of the parasite were discovered, and that one could be absolutely certain of its presence. The vine which showed the first and most marked attack was the third vine of the seventh row, situated in the middle untreated portion.

At the end of a week of damp weather consisting of fog and sometimes even heavy rain, the black-rot had extended over the entire vineyard, but had developed in very different degrees.

The three check rows (sixth, seventh, and eighth) were everywhere invaded; there were but few branches left untouched, while some did not preserve one leaf intact and many leaves bore from thirty to fifty spots.

The spots were much less numerous on the rows treated by eau celeste and the sulphate of copper solution, and were still more rare upon the three rows treated with Bordeaux mixture. The last rows (twelfth and thirteenth) had, however, but few spots of attack.

Outside this vineyard the disease gained ground everywhere, new centers of infection appearing at various points around Aiguillon, in vineyards which had been entirely free from the disease the preceding year.

At the end of June, after a series of storms accompanied by a temperature constantly warm and humid, the disease continued its progress; the spots upon the leaves multiplied, even in the ninth, tenth, and eleventh rows, but conceptacles were rare in the latter.

A second treatment like the first was given to each row June 22, 23, and 25.

At the beginning of July the leaves on the check rows were completely covered with spots, but the grapes were still very fine and entirely intact.

July 2 and 3 a third treatment with Bordeaux mixture was given in the uniform proportion of 6 parts copper to 100 of water to the ninth, tenth, eleventh, twelfth, and thirteenth rows, with eau celeste in the proportions of one-half parts copper to 100 of water to the second and third rows, and with the sulphate of copper solution in the proportion of 3 parts to 1,000 of water to the fifth row.

The disease did not seem to make any obvious progress upon the foliage of the treated rows. July 12, after rain of several days, the first black-rot was discovered upon a few berries in the untreated rows (sixth, seventh, and eighth). On the 13th the clusters of these three rows were completely invaded. A few diseased clusters could also be seen in the other rows.

On the 16th the disease had progressed to a frightful extent, and the crop on the untreated vines was entirely destroyed. Up to the 19th the diseased berries were livid and soft, and it was not until the close of that day that they became dry and black and covered by the conceptacles of the parasite.

Between the 12th and the 20th of July the black-rot had accomplished its work of destruction.

July 25, M. Lavergne noted the exact number of berries remaining healthy, and those more or less badly diseased upon each vine in each of the eleven rows. I have compiled the results of this patient and laborious observation in the accompanying table, in which is stated the true number of vines in each row (several feeble stocks having been torn up and renewed, and hence of no account in the experiment), the number of healthy grape clusters and the number attacked slightly, badly, or completely destroyed by the disease; these numbers are based upon the scale of 100 in order to render the proportions easy of comparison in the different rows.

The last columns state the number of vines in each row that were badly or very badly attacked the preceding year.

It will be seen that in the check rows (sixth, seventh, and eighth) the total number of clusters attacked was 94.81, 96.88, and 99.77 per 100. This is equivalent to total destruction.

On the contrary, in the three rows treated with the Bordeaux mixture (ninth, tenth, and eleventh) the number of clusters attacked was only 13.81, 21.92, and 24.66, and besides it should be remarked that nearly all were slightly affected, not one being entirely destroyed.

From this experiment I do not venture to decide regarding the quantity of ingredients to be preferred in the use of Bordeaux mixture. Although the row which received at the first two treatments with the mixture made according to the old formula (7 kilograms of sulphate of copper and 15 kilograms of lime to a hectoliter of water) had a smaller proportion of diseased grapes, it should be taken into consideration that in 1887 it was notably freer from black-rot than the next row. The first treatments appeared to affect the three rows much the same, and at the last two the vines received a uniform quantity of 6 parts of sulphate of copper and 6 parts of lime to 100 of water, which was perhaps stronger than was necessary. The treatment of the remainder of the vineyard, made with 3 parts of sulphate of copper and 2 parts of lime to 100 of water, appears to have produced good results.

The effects of the treatment with eau celeste were much less satisfactory than those obtained with Bordeaux mixture. In one of these rows (third) the number of diseased clusters was 56.93 per 100; in the other (fourth) it was 74.60.

It should always be remembered that on one side there were many clusters among them only slightly affected, and on the other that these rows were badly diseased this year by anthracnose, and in more than one case the damage caused by this disease appears to have aggravated the injuries produced by black-rot.

The results of the treatment with the sulphate of copper solution were even less satisfactory, 85.34 per 100 of the berries being diseased.

The rows upon which the two first treatments were made, either with cupric steatite (twelfth row, first part) or Carrére powder (twelfth row, second part and annex), suffered as much from the disease as those which received no treatment, the proportion of diseased clusters being 97.78 and 98.05 per 100.

Rows.	Mode of treatment of different rows.	Number of plants.	Healthy clusters.		Diseased clusters—								Diseased plants in 1887.			
					Slightly affected.		Badly affected.		Destroyed.		Total.		Badly affected.	Very badly affected.	Total.	Per 100.
			No.	Per 100.	No.	Per 100.	No.	Per 100.	No.	Per 100.	No.	Per 100.				
3	Eau celeste	39	115	43.07	131	49.07	18	6.75	3	1.11	152	56.93	14	3	17	34
4	....do	49	127	25.40	238	47.60	106	21.20	29	5.80	373	74.60	9	19	28	56
5	Solution of sulphate of copper.	49	72	14.66	299	60.90	101	20.57	19	3.87	419	85.34	4	10	14	28
6	Check	49	22	5.19	139	32.79	159	37.50	104	24.52	402	94.81	2	9	11	22
7	....do	40	15	3.12	18	3.74	174	36.17	274	56.97	466	96.88	5	26	31	62
8	....do	40	1	.23	55	12.88	168	39.35	203	47.54	426	99.77	1	6	7	14
9	Bordeaux mixture	41	337	86.19	53	13.55	1	.26	.....	......	54	13.81	23	4	27	54
10	....do	36	324	78.08	88	21.21	3	.72	.....	......	91	21.92	....	50	50	100
11	....do	36	223	75.34	66	22.30	7	2.36	.....	......	73	24.66	26	7	33	66
12	First part cupric steatite	25	4	2.22	10	5.55	82	45.56	84	46.67	176	97.78	15	7	22	88
	Second part carrere powder	12	.....	1.95	13	9.09	56	67.53	29	21.41	98	98.05	2	....	2	8
	Annex Carrére powder	9	3		1		48		4		53		...	...	....	
13	Pulverized sulphate of copper and triturated sulphur	19	38	30.65	48	38.71	19	15.32	19	15.32	86	69.35	29	..	29	58

The pulverized sulphate of copper (thirteenth row) appeared to be a little more efficacious; the number of diseased clusters upon the plants thus treated was only 69.35 per 100.

The experiments at Aiguillon show very clearly that the copper treatment, particularly that of Bordeaux mixture, will enable us to successfully combat the formidable disease of black-rot, which, after having desolated the vines of America for many years without anything being known to arrest its ravages, is now appearing in places more and more numerous in our country. * * *

We can no longer deceive ourselves in this matter; it is unhappily much to be feared that the disease will sooner or later reach all the vineyards as the oidium has done and as the mildew has done, but we shall certainly be able to retard the progress of the invasion if suitable and timely treatment is applied at the centers of infection. * * *

From this year on it will be of the greatest importance to very carefully collect and destroy all the grapes that have become blackened and dried by black-rot. It is well known that these are the berries upon which develop during the winter the fruit bodies which play the largest part in reproducing the fungus from one year to another and spreading the disease far and wide. The dried spores can easily be borne by the wind to considerable distances and the winter form of fruit has the property of projecting its fine spores so far as to greatly facilitate their dissemination. Without doubt much of the fruit destroyed by the disease will have already fallen upon the ground at the time of vintage; not all of this will be collected, but by the destruction of the greatest possible number of the grapes which have been dried up by black-rot the chances of the re-appearance and extension of the evil the following year will be diminished by so much, and the success of the copper treatment be made more easy and complete.

It is to be hoped that in all those districts where black-rot has been discovered, the mayor will publish at the time of the vintage a notice directing the cultivators to collect and destroy by fire all the dried grapes found by the vintagers so that none shall be left upon the vines.

The coming spring, in all these localities where the black-rot has been discovered this year, the first preventive treatment by Bordeaux mixture should be made in the second half of May, and later the applications of the remedy should be renewed as soon as the characteristic spots appear upon the leaves.

It is true that the year 1888 has been exceptionally moist and favorable to the development of cryptogamic diseases; it is quite natural to think that another year the black-rot will not be so well developed, and will be more easy to combat. I believe that we can confidently expect that where the destruction of the dried grapes is as complete as possible, and where timely copper treatment is given, the destruction caused by black-rot will be reduced in a very considerable degree, and that this new disease will cause but little injury even in those places which were first infected.

EMBER 20, 1888.

At present the black-rot is not spreading, but since the time of collecting the data contained in the above report the disease has continued to cause some injuries which should be here noted.

In the ninth row, which received the first two treatments of Bordeaux mixture in the proportion of 7 parts of sulphate of copper and 15 parts of lime to 100 of water, the disease has grown no worse. The proportion continues to be eighty-five healthy berries to fifteen diseased ones. But in the following rows, which received the first two treatments of Bordeaux mixture containing 6 or 3 parts of sulphate of copper, the disease has increased 10 per cent. In the tenth row, which was treated in the beginning with 6 parts of sulphate of copper and 6 parts of lime to 100 of water, there are seventy healthy clusters for thirty diseased ones, and in the following row, which received at the first treatments the solution containing 3 parts of sulphate of copper and 2 parts of lime, there are sixty five healthy berries for thirty five diseased ones.

A fifth and last treatment with 6 parts of sulphate of copper and 6 parts of lime was applied August 5, both to the two latter rows and to those which were first treated with Bordeaux mixture made after the old formula (7 parts of sulphate of copper and 15 parts of lime).

It is then undoubtedly the use of Bordeaux mixture, containing 7 parts of sulphate of copper and 15 parts of lime, which was most efficacious, at least for the first treatments, in preserving grapes from the black-rot.

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